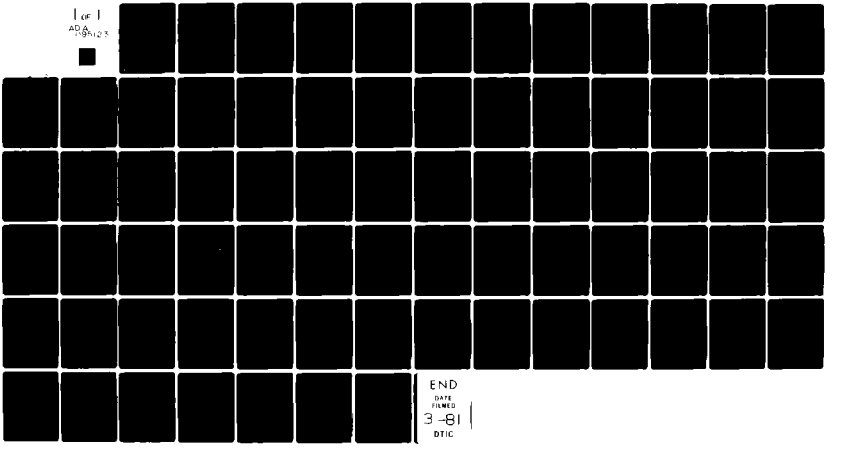
AD-A095 123 AIR FORCE MATERIALS LAB WRIGHT-PATTERSON AFB OH F/G 11/4
TI-59 MAGNETIC CARD CALCULATOR SOLUTIONS TO COMPOSITE MATERIALS--ETC(U)
JAN 81 S W TSAI, R AOKI
UNCLASSIFIED AFML-TR-79-4040-REV NL



AFML-TR-79-4040 (Revised)
(Original report issued April 1979)

TI-59 MAGNETIC CARD CALCULATOR SOLUTIONS TO COMPOSITE MATERIALS FORMULAS

Stephen W. Tsai
Rodolfo Aoki

Mechanics & Surface Interactions Branch
Nonmetallic Materials Division

JANUARY 1981

TECHNICAL REPORT AFML-TR-79-4040 (Revised)
Final Report for Period January 1980 to December 1980

MATERIALS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporations, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NITS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

S. W. TSAI, Project Engineer & Chief
Mechanics & Surface Interactions Br.
Nonmetallic Materials Division

FOR THE COMMANDER

F. D. CHERRY, Chief
Nonmetallic Materials Division

"If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization, please notify AFWAL/MLBM , W-PAFB, Ohio 45433 to help us maintain a current mailing list".

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

AIR FORCE/56780/28 January 1981 — 400

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: AFML-TR-79-4040 (Rev)	2. GOVT ACCESSION NO.: AD-A095 123
3. RECIPIENT'S CATALOG NUMBER: (9)	
4. TITLE (and Subtitle): TI-59 MAGNETIC CARD CALCULATOR SOLUTIONS TO COMPOSITE MATERIALS FORMULAS. Revision.	5. TYPE OF REPORT & PERIOD COVERED: Interim Final Report January 1980-December 1980
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): (10) Stephen W. Tsai, Rodolfo Aoki	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Materials Laboratory (AFWAL/MLBM), Air Force Systems Command, Wright-Patterson AFB, OH 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (16) 24190310 (17) 03
11. CONTROLLING OFFICE NAME AND ADDRESS: Materials Laboratory (AFWAL/MLBM), Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, OH 45433	12. REPORT DATE: (11) January 1981
	13. NUMBER OF PAGES: 68
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: (12) 74	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Magnetic Card Programs
Composite Materials
Properties of Unidirectional & Laminated Composites
In-Plane and Flexural Stiffness & Strength
Nonmechanical Resultants & Moments
Asymmetric Laminates

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This volume contains the description and instructions of magnetic cards for TI-59 programmable calculators. These tapes contain the key calculations of the stiffness and strength of unidirectional and laminated composites. Both in-plane and flexural loadings can be applied. The initial stress and strain due to curing and moisture adsorption are also included in the strength calculation. With the aid of the magnetic cards, instant calculations can be made for practical use. The use of cards is also an effective teaching tool.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

ØLJ32Ø

The formulas used in the cards and equation numbers have been derived in a book entitled, Introduction to Composite Materials, coauthored by S. W. Tsai and H. T. Hahn, published by Technomic Publishing Company, Westport, CT, July 1980. This TR a revised edition of the technical report bearing the same number published in April 1979.

FOREWORD

This report was prepared in the Mechanics and Surface Interactions Branch (AFWAL/MLBM), Nonmetallic Materials Division, Materials Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio. The work was performed under the support Project No. 2419, "Nonmetallic Structural Materials", Task No. 241903, "Composite Materials and Mechanics Technology". The time period covered by this effort was from January to December 1980. Stephen W. Tsai (AFWAL/MLBM) was the laboratory project engineer. Rodolfo Aoki was a visiting scientist with MLBM from the German Aerospace Research Establishment (DFVLR).

This is a revised edition of the technical report bearing the same number published in April 1979. The asymmetric laminate tapes are added in this revision. The equations and table numbers which appear in the flow charts are the same as in Introduction to Composite Materials, coauthored by S. W. Tsai and H. T. Hahn, published by Technomic Publishing Company, Westport, CT, in July 1980.

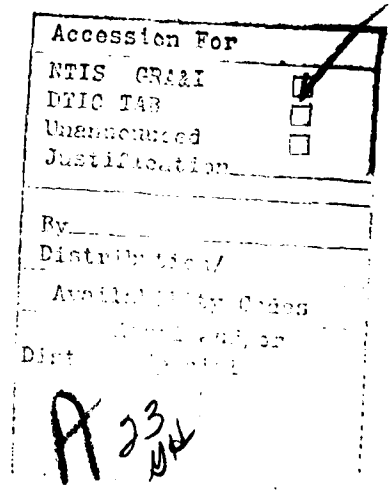
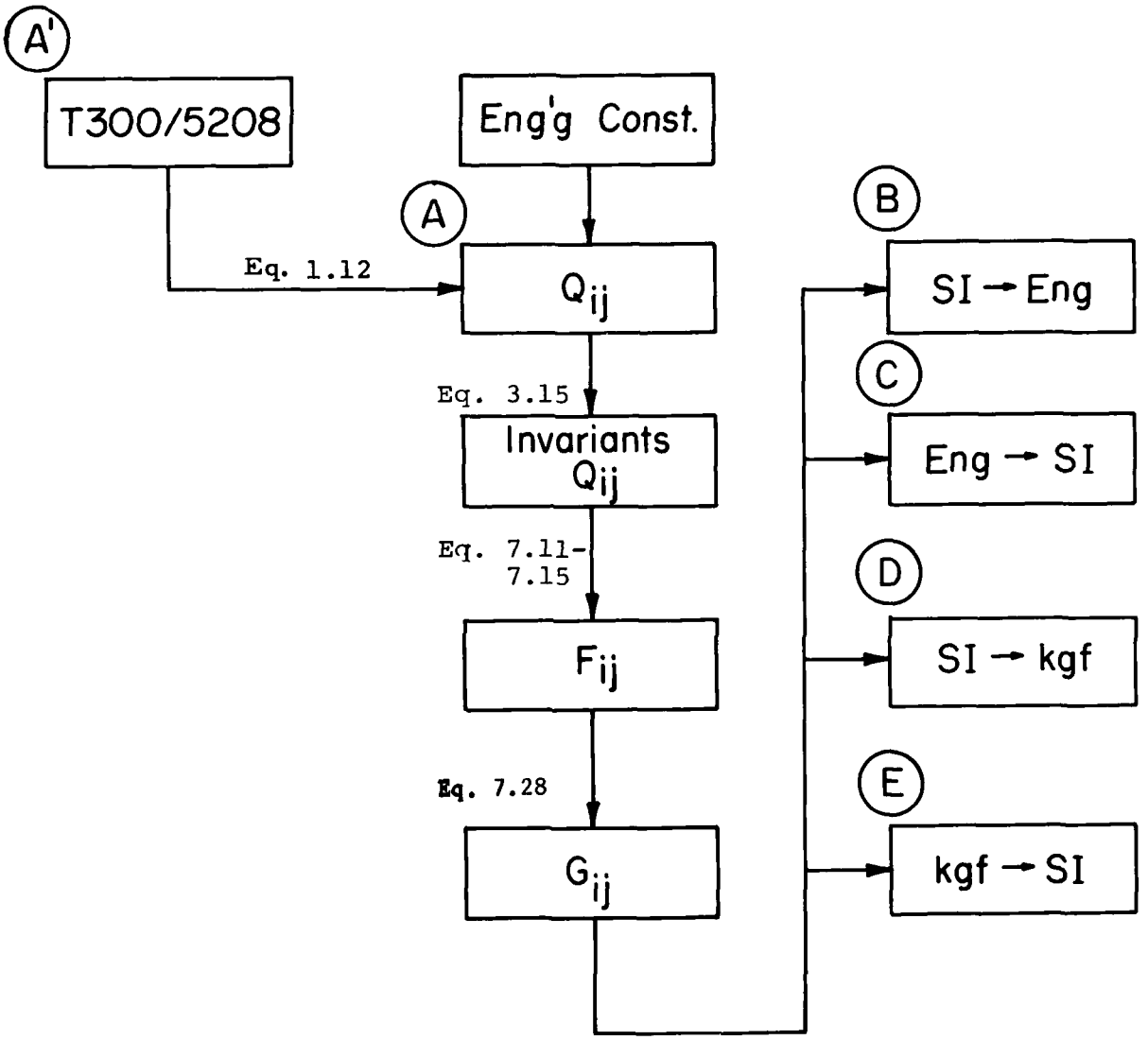


TABLE OF CONTENTS

TAPE #1
PROPERTIES OF UNIDIRECTIONAL COMPOSITES



USER INSTRUCTIONS

TAPE #1: PROPERTIES OF UNIDIRECTIONAL COMPOSITES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	For T300/5208 plies, initialize values of $E_x, E_y, \nu_x, E_s, X, X', Y, Y', S, F^*_{xy}$ ($= -1/2$), $\alpha_x, \alpha_y, \alpha_x, \alpha_y$, and h_o in SI.	--	A'	1.00
	Calculate Q_{ij} invariants $\frac{1}{2}(U_1 + U_4)$, U_5 U_2, and U_3; stress failure tensors F_i and F_{ij}; strain failure tensors G_i and G_{ij}.			1.00
2	Convert from SI to English (lb, in, °F) units.	--	B	1.00
3	Convert from English to SI units.	--	C	1.00
4	Convert from SI to kgf (kgf, mm, °C) units.	--	D	1.00
5	Convert from kgf to SI units	--	E	1.00
Alternatives				
0A	Clear memory		CMs	
1A	To initialize other values of E_x,	E_x	STO 18	E_x
	..., h_o, the values may be stored	.	.	.
	manually in the data registers.	.	.	.
2A	Calculate Q_{ij}, U's, F_i, F_{ij}, etc.	--	A	1.00

Then Steps 2-5 can be performed as appropriate. For example, one can initialize in Eng. units and convert to SI by using Step 3.

Computed ply data should be recorded in blocks 3 and 4 for future use. Tape #1 need not be run, unless a change in unit (e.g. from SI to Eng) or change in properties is desired.

Tape #1 Title PROPERTIES OF UNIDIRECTIONAL COMPOSITES

A' Initialize T300/5208	B'	C'	D'	E'
A Initialize Other Mat'l	B SI to English	C English to SI	D SI to kgf/mm^2	E kgf/mm^2 to SI

00	15 Y	30 Q_{ss}	45 U_3
01 Q_{xx}	16 Y'	31	46 F_{xx}
02 Q_{yy}	17 S	32	47 F_x
03 Q_{xy}	18 E_x	33	48 F_{yy}
04	19 E_y	34	49 F_y
05	20 ν_x	35	50 F^*_{xy}
06	21 E_s	36	51 F_{xy}
07	22 α_x	37	52
08	23 α_y	38	53
09	24 β_x	39 m	54 G_{xx}
10	25 β_y	40	55 G_{yy}
11	26	41 h_o	56 G_{xy}
12	27 Q_{xx}	42 $\frac{1}{2}(U_1+U_4)$	57 G_{ss}
13 X	28 Q_{yy}	43 $U_5=\frac{1}{2}(U_1-U_4)$	58 G_x
14 X'	29 Q_{xy}	44 U_2	59 G_y

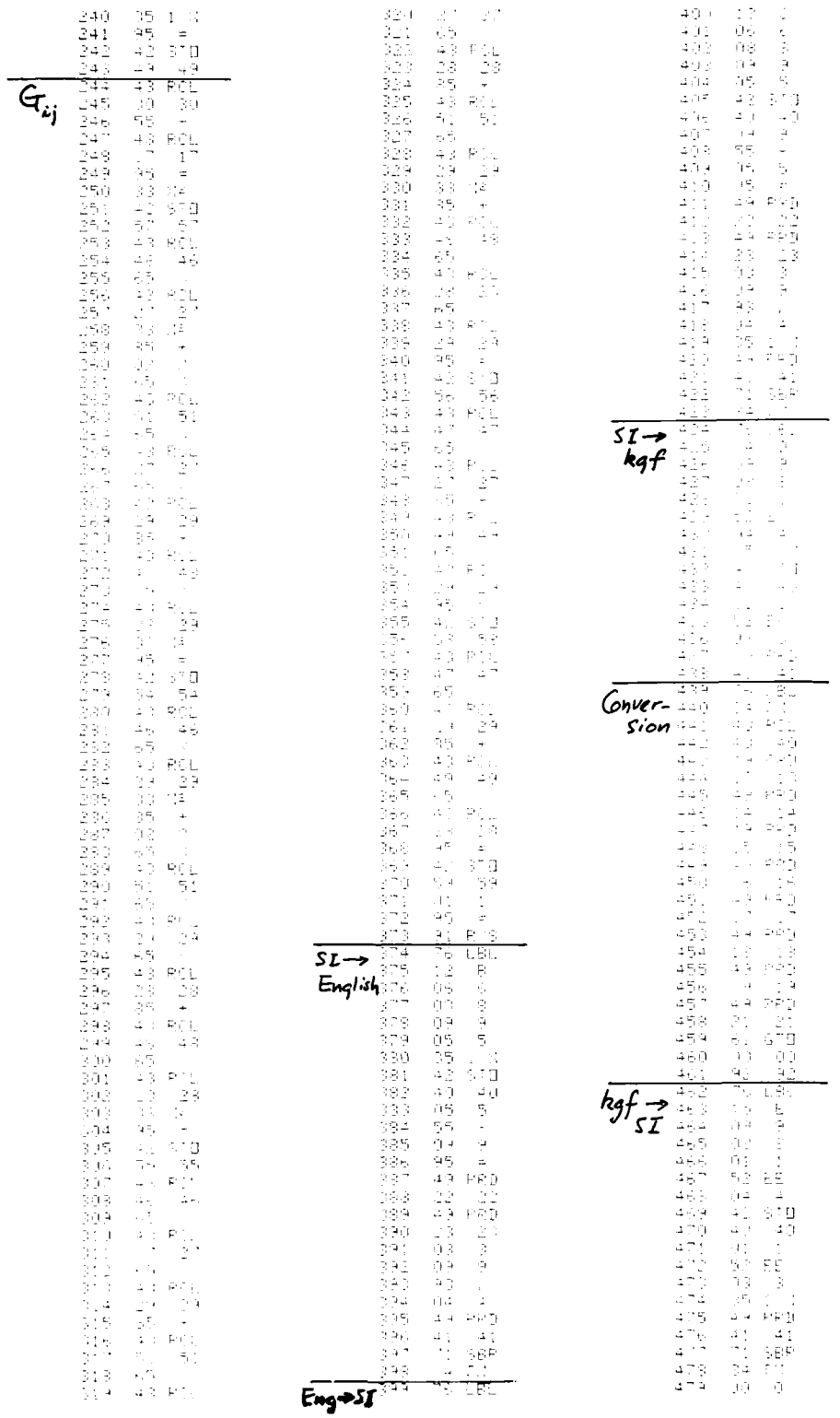
T300-5208

000	76	LBL		080	24	CP		160	43	RCL	
001	16	A'		081	93	.		161	75	-	
002	01	1		082	06	6		162	43	RCL	
003	07	7		083	42	STO		163	30	30	
004	16	PAU		084	25	25		164	95	=	
005	47	CMS		085	01	1		165	42	STO	
006	57	ENG		086	02	2		166	45	45	
007	01	1		087	05	5		167	43	RCL	
008	06	6		088	53	EE		168	30	30	
009	01	1		089	34	FX		169	85	+	
010	53	EE		090	06	6		170	43	RCL	
011	09	9		091	42	STO		171	28	28	
012	42	STO		092	41	41		172	85	+	
013	18	18		093	76	LBL		173	02	2	
014	01	1		094	11	A		174	65	×	
015	00	0		095	57	ENG		175	43	RCL	
016	03	3		096	43	RCL		176	29	29	
017	53	EE		097	20	20		177	95	=	
018	03	3		098	35	1/X		178	55	÷	
019	42	STO		099	65	×		179	04	4	
020	19	19		100	43	RCL		180	45	=	
021	43	RCL		101	19	19		181	42	STO	
022	00	0		102	55	÷		182	42	42	
023	06	6		103	43	RCL		183	43	RCL	
024	42	STO		104	18	18		184	27	27	
025	20	20		105	75	-		185	55	÷	
026	43	RCL		106	01	1		186	43	RCL	
027	00	0		107	95	=		187	28	28	
028	04	4		108	44	SUM		188	95	=	
029	53	EE		109	35	1/X		189	50	IND	
030	07	7		110	42	STO		190	55	÷	
031	42	STO		111	34	FX		191	02	2	
032	21	21		112	55	÷		192	95	=	
033	01	1		113	43	RCL		193	42	STO	
034	06	6		114	19	19		194	44	44	
035	53	EE		115	45	=		195	43	RCL	
036	08	8		116	42	STO		196	13	13	
037	42	STO		117	27	27		197	65	×	
038	13	13		118	42	STO		198	43	RCL	
039	42	STO		119	01	01		199	14	14	
040	14	14		120	43	RCL		200	95	=	
041	04	4		121	29	29		201	85	+	
042	53	EE		122	55	÷		202	42	STO	
043	07	7		123	43	RCL		203	46	46	
044	42	STO		124	19	19		204	43	RCL	
045	15	15		125	95	=		205	13	13	
046	02	2		126	42	STO		206	35	1/X	
047	06	6		127	28	28		207	75	-	
048	04	4		128	42	STO		208	43	RCL	
049	53	EE		129	00	00		209	14	14	
050	07	7		130	65	×		210	35	1/X	
051	42	STO		131	43	RCL		211	95	=	
052	16	16		132	20	20		212	42	STO	
053	02	2		133	95	=		213	47	47	
054	06	6		134	42	STO		214	43	RCL	
055	53	EE		135	29	29		215	15	15	
056	08	8		136	42	STO		216	65	×	
057	42	STO		137	03	03		217	43	RCL	
058	17	17		138	43	RCL		218	16	16	
059	43	RCL		139	21	21		219	95	=	
060	00	0		140	42	STO		220	35	1/X	
061	44	SUM		141	30	30		221	42	STO	
062	11	A		142	65	×		222	48	48	
063	01	1		143	04	4		223	65	×	
064	11	A		144	75	-		224	43	RCL	
065	53	EE		145	02	2		225	46	46	
066	43	RCL		146	55	÷		226	95	=	
067	16	16		147	43	RCL		227	85	+	
068	42	STO		148	24	24		228	65	×	
069	12	12		149	85	+		229	43	RCL	
070	01	1		150	43	RCL		230	50	50	
071	00	0		151	23	23		231	95	=	
072	05	5		152	85	+		232	42	STO	
073	53	EE		153	43	RCL		233	51	51	
074	43	RCL		154	28	28		234	43	RCL	
075	17	17		155	95	=		235	15	15	
076	42	STO		156	55	÷		236	65	×	
077	13	13		157	00	0		237	75	-	
078	01	1		158	45	=		238	43	RCL	
079	42	STO		159	42	STO		239	16	16	

New Mat'l

Q_{ij}

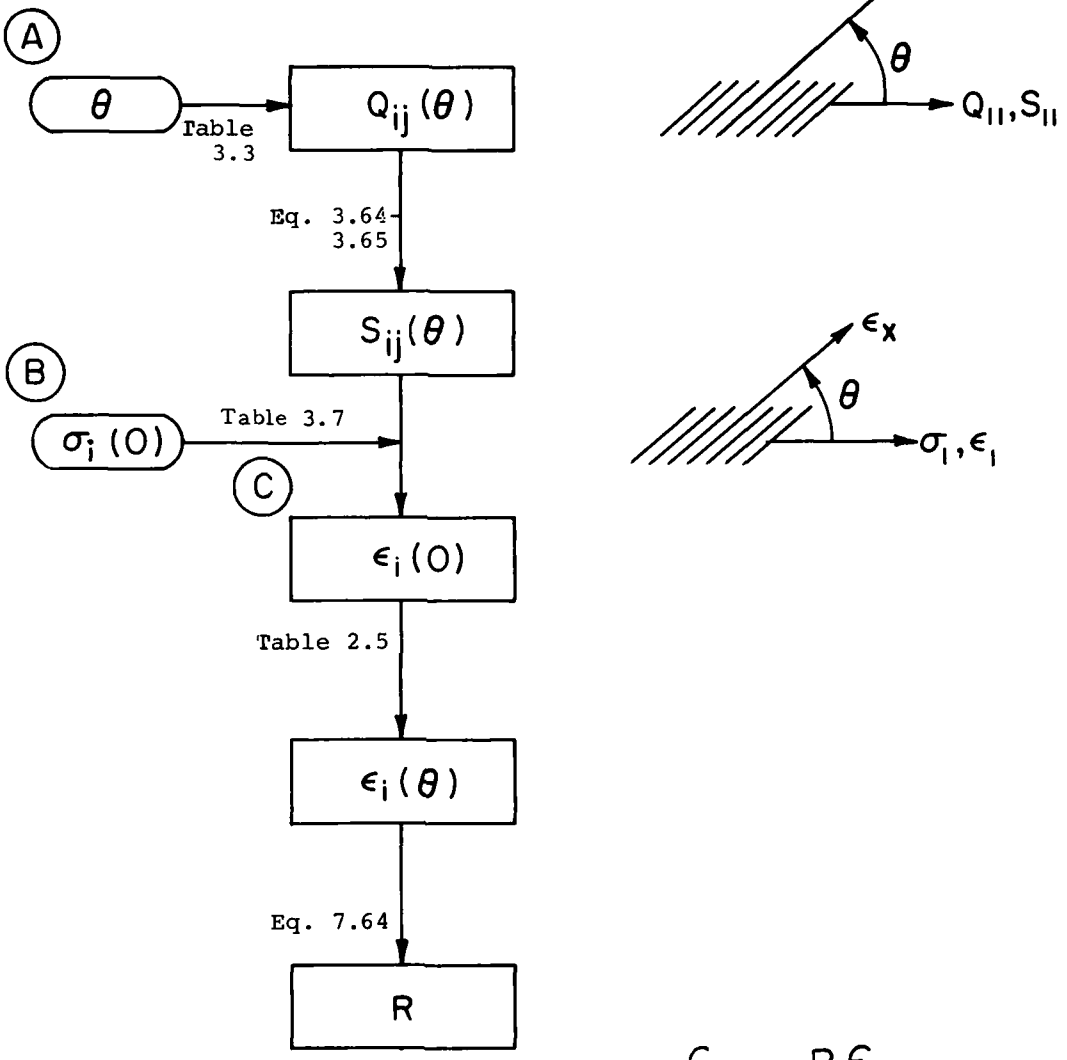
F_{ij}


G_{ij}
SI → English
Eng → SI
SI → kgf
Conver-sion
kgf → SI

TAPE #1 PROPERTIES OF UNIDIRECTIONAL/SAMPLE PROBLEMS

	T300/5208			AS/3501		
	SI	ENG.	Kgf/MM^2	SI	ENG.	
	0. 00	0. 00	0. 00	0. 00	0. 00	00
	181.31114 09	26.308548 06	18.533246 03	138.78041 09	20.127688 06	01
	10.346159 09	1.5006306 06	1.0546543 03	9.0162185 09	1.3076459 06	02
	2.8969244 09	420.14858 03	295.30321 00	2.7048656 09	392.29377 03	03
	0. 00	0. 00	0. 00	0. 00	0. 00	04
	0. 00	0. 00	0. 00	0. 00	0. 00	05
	0. 00	0. 00	0. 00	0. 00	0. 00	06
	0. 00	0. 00	0. 00	0. 00	0. 00	07
	0. 00	0. 00	0. 00	0. 00	0. 00	08
	0. 00	0. 00	0. 00	0. 00	0. 00	09
	0. 00	0. 00	0. 00	0. 00	0. 00	10
	0. 00	0. 00	0. 00	0. 00	0. 00	11
	0. 00	0. 00	0. 00	0. 00	0. 00	12
	1.5 09	217.54895 03	152.9052 00	1.44795 09	210. 03	13
	1.5 09	217.54895 03	152.9052 00	1.44795 09	210. 03	14
	40. 06	5.8013053 03	4.077472 00	51.7125 06	7.5 03	15
	346. 06	35.673021 03	25.076453 00	206.85 06	30. 03	16
	68. 06	9.8622218 03	6.9317023 00	93.0825 06	13.5 03	17
	181. 09	26.250506 06	18.450561 03	137.96895 09	20.01 06	18
	10. 09	1.4933361 06	1.049949 03	8.9635 09	1.3 06	19
	280. -03	280. -03	280. -03	300. -03	300. -03	20
	10. 09	1.4503053 06	730.88685 00	7.10185 09	1.03 06	21
	10. -09	5.5555554 -09	10. -09	10. 09	5.5555554 09	22
	12.5-06	6.9444444-06	12.5-06	12.5-06	6.9444444-06	23
	0. 00	0. 00	0. 00	0. 00	0. 00	24
	600. -03	600. -03	600. -03	600. -03	600. -03	25
	0. 00	0. 00	0. 00	0. 00	0. 00	26
Q_{ij}	181.31114 09	26.308548 06	18.533246 03	138.78041 09	20.127688 06	27
Q_{ij}	10.346159 09	1.5006306 06	1.0546543 03	9.0162185 09	1.3076459 06	28
Q_{ij}	2.8969244 09	420.14858 03	295.30321 00	2.7048656 09	392.29377 03	29
Q_{ij}	10. 09	1.4503053 06	730.88685 00	7.10185 09	1.03 06	30
	0. 00	0. 00	0. 00	0. 00	0. 00	31
	0. 00	0. 00	0. 00	0. 00	0. 00	32
	0. 00	0. 00	0. 00	0. 00	0. 00	33
	0. 00	0. 00	0. 00	0. 00	0. 00	34
	0. 00	0. 00	0. 00	0. 00	0. 00	35
	0. 00	0. 00	0. 00	0. 00	0. 00	36
	0. 00	0. 00	0. 00	0. 00	0. 00	37
	0. 00	0. 00	0. 00	0. 00	0. 00	38
	1.0044814 00	1.0044814 00	1.0044814 00	1.0058815 00	1.0058815 00	39
	0. 00	145.03263-06	101.9368-09	0. 00	145.03263-06	40
	135. -06	4.925-03	135. -03	135.34846-06	5.2499893-03	41
	43.4[illegible] 09	7.177344 06	5.0446266 03	38.10159 09	5.5549804 06	42
	29.[illegible]411 09	3.8985397 06	2.7401051 03	21.142287 09	3.0963433 06	43
	35.[illegible]849 09	12.434009 06	8.7392956 03	44.680096 09	9.4100211 06	44
	19.710421 09	2.8586557 06	2.0092183 03	14.[illegible]437 09	2.0663433 06	45
	444.44444-21	21.129344-12	48.7716-06	472.[illegible]193-21	22.675737-12	46
	0. 00	0. 00	0. 00	0. 00	0. 00	47
	101.[illegible]602-18	4.831405-09	9.7800915-03	93.[illegible]6509-18	4.4444444-09	48
	20.934959-09	144.34654-06	205.37195-03	14.[illegible]283-09	100.-06	49
	-500. -03	-500. -03	-500. -03	0. 00	0. 00	50
	-3.[illegible]02243-18	-159.75326-12	-323.38451-06	0. 00	0. 00	51
	0. 00	0. 00	0. 00	0. 00	0. 00	52
	0. 00	0. 00	0. 00	0. 00	0. 00	53
G_{ij}	12.004384 03	12.004384 03	12.004384 03	9.[illegible]704565 03	9.8704565 03	54
G_{ij}	10.[illegible]80652 03	10.680652 03	10.680652 03	7.[illegible]032133 03	7.6032133 03	55
G_{ij}	-3.0691032 03	-3.0691032 03	-3.0691032 03	2.45896[illegible] 03	2.4589639 03	56
G_{ij}	11.117843 03	11.117843 03	11.117843 03	5.[illegible]11248 03	5.8311248 03	57
G_{ij}	60.646995 00	60.646995 00	60.646995 00	39.[illegible]77 00	39.3299377 00	58
G_{ij}	216.59641 00	216.59641 00	216.59641 00	130.76459 00	130.76459 00	59

TAPE #2
OFF-AXIS PROPERTIES OF UNIDIRECTIONAL COMPOSITES



$$\epsilon_{i(a)} = R\,\epsilon_i$$

$$\sigma_{i(a)} = R\,\sigma_i$$

USER INSTRUCTIONS

TAPE #2: OFF-AXIS PROPERTIES OF UNIDIRECTIONAL COMPOSITES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Ply data must be in storage			
1	Calculate modulus Q_{ij} and compliance S_{ij} in rotated coordinate system at angle θ (positive counterclockwise) to reference coordinates	θ	A	1.00
2	Input applied stresses in reference coord. system. If unit stresses, such as [1,0,0], are entered, the resulting R values are the allowable strengths.	σ_1	B	σ_1
		σ_2	R/S	σ_2
		σ_6	R/S	σ_6
3*	Calculate corresponding strains in reference and material coord. systems and calculate strength ratios R & R'. (defined as the ratios by which the applied loading must be multiplied to reach the failure surface).	--	C	R
		--	R/S	R'
Alternative A				
2A	Input applied strains in reference coord. system	ϵ_1	STO 10	ϵ_1
		ϵ_2	STO 11	ϵ_2
		ϵ_6	STO 12	ϵ_6
3A	Calculate strains in material coord. system, and calculate strength-strain ratios R and R'.	--	D	R
		--	R/S	R'
Alternative B				
2B	Input strains in material coords. (Step 0 needed, but Step 1 not needed)	ϵ_x	STO 07	ϵ_x
		ϵ_y	STO 08	ϵ_y
		ϵ_s	STO 09	ϵ_s
3B	Calculate strength ratios R & R'.	--	E	R
		--	R/S	R'

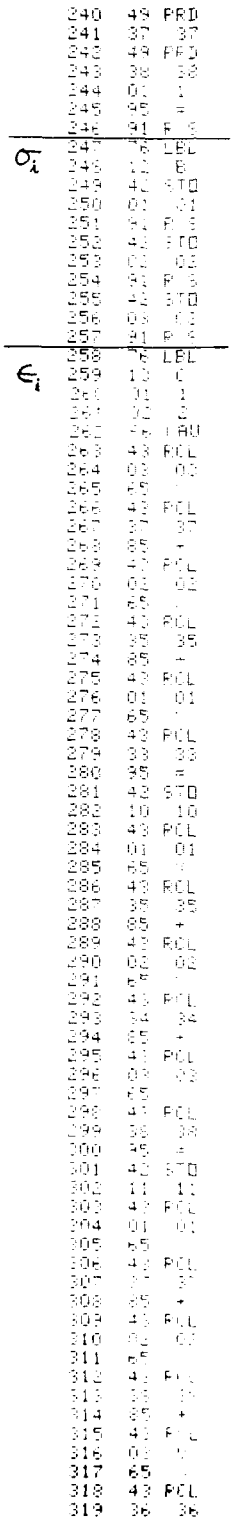
* Steps 0, 1 and 2 must be executed at least once before Step 3.
If only the angle in Step 1 is changed while the stress remains the same Step 2 can be skipped. If the stress is changed while the angle remains constant, Step 1 can be omitted.

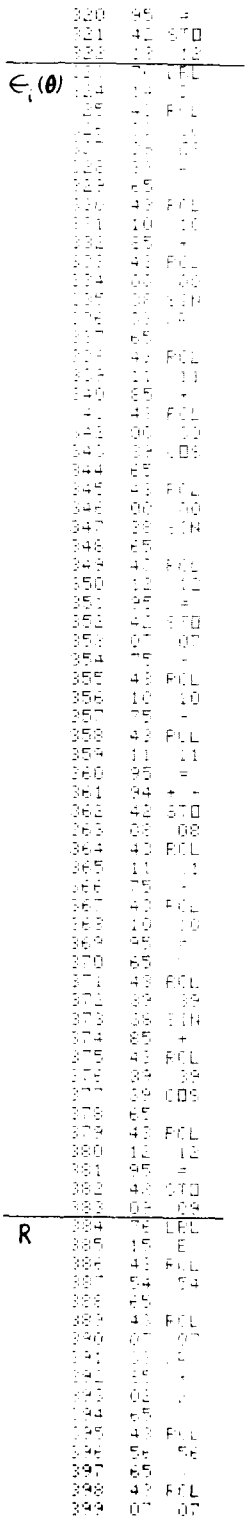
Tape# 2 Title OFF-AXIS PROPERTIES OF UNIDIRECTIONAL COMPOSITES

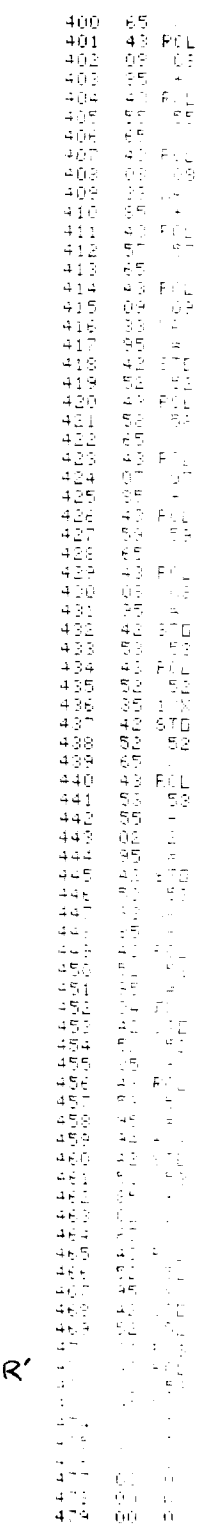
A'	B'	C'	D'	E'
A θ	B $[\sigma_1, \sigma_2, \sigma_6]$	C R	D R from $[e_1, e_2, e_6]$	E R from $[e_x, e_y, e_s]$
00 θ	15	30 Q_{66}	45 U_3	
01 σ_1	16	31 Q_{16}	46	
02 σ_2	17	32 Q_{26}	47	
03 σ_6	18	33 S_{11}	48	
04	19	34 S_{22}	49	
05	20	35 S_{12}	50	
06	21	36 S_{66}	51	
07 e_x	22	37 S_{16}	52 ...R	
08 e_y	23	38 S_{26}	53 ...R'	
09 e_s	24	39 2θ	54 G_{xx}	
10 e_1	25	40 4θ	55 G_{yy}	
11 e_2	26 $\lvert Q \rvert$	41 h_o	56 G_{xy}	
12 e_6	27 Q_{11}	42 $\frac{1}{2}(U_1+U_4)$	57 G_{ss}	
13	28 Q_{22}	43 $U_5=\frac{1}{2}(U_1-U_4)$	58 G_x	
14	29 Q_{12}	44 U_2	59 G_y	

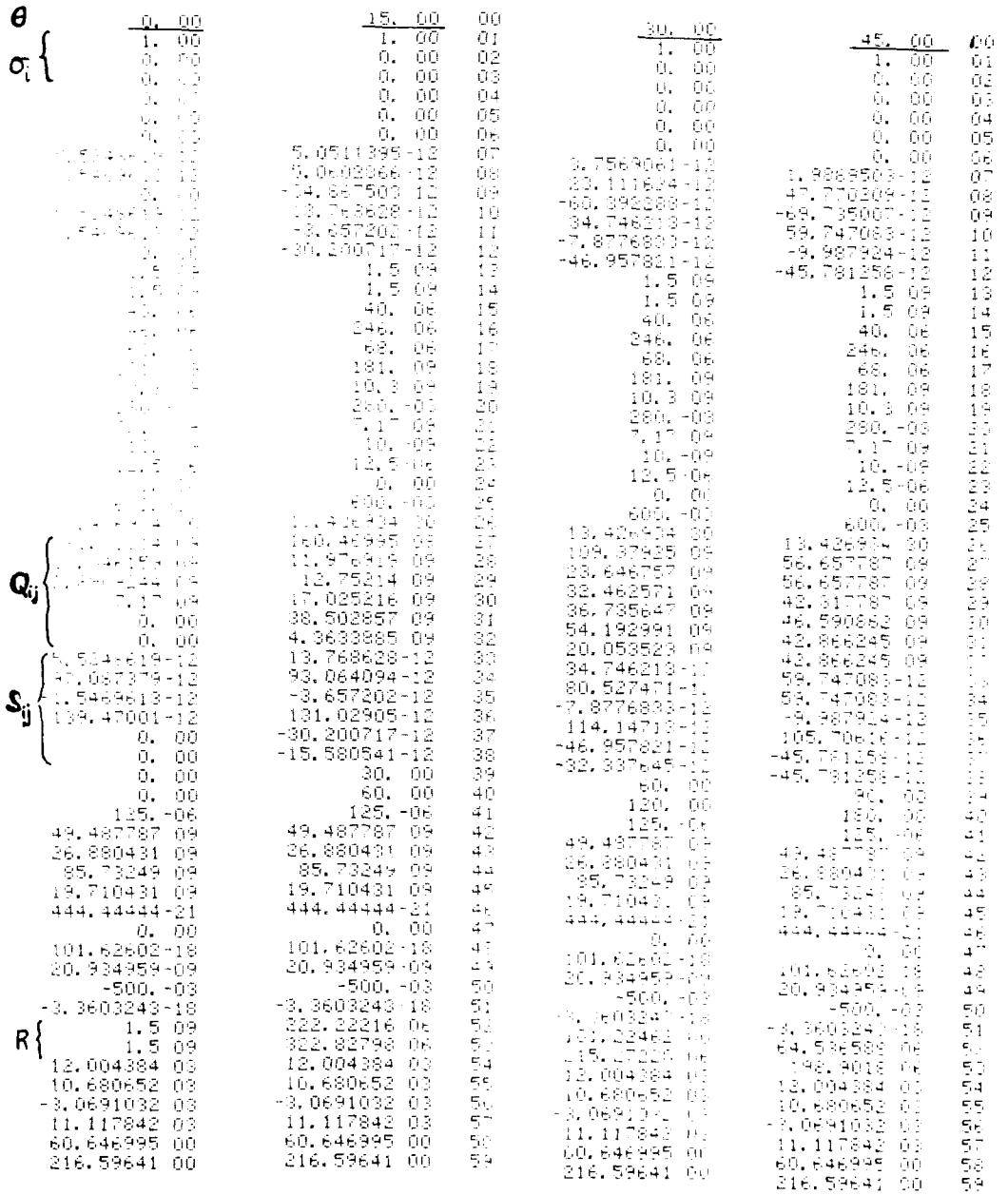
Tape #2 Off-Axis Properties

θ	000	76	LBL		080	38	SIN		160	95	=
	001	11	A		081	55	÷		161	42	STO
	002	57	ENG		082	02	2		162	33	33
	003	42	STO		083	65	×		163	43	RCL
	004	00	00		084	43	RCL		164	27	27
	005	65	×		085	44	44		165	65	×
	006	02	2		086	95	=		166	43	RCL
	007	95	=		087	65	×		167	28	28
	008	42	STO		088	43	RCL		168	75	-
	009	39	39		089	40	40		169	43	RCL
	010	65	×		090	38	SIN		170	29	29
	011	02	2		091	65	×		171	33	X²
	012	95	=		092	43	RCL		172	95	=
	013	42	STO		093	45	45		173	42	STO
	014	40	40		094	95	=		174	36	36
	015	01	1		095	43	RCL		175	43	RCL
	016	03	3		096	31	31		176	27	27
	017	56	FAU		097	75	-		177	65	×
Q_{ij}	018	43	RCL		098	43	RCL		178	43	RCL
	019	42	42		099	34	34		179	30	30
	020	85	+		100	38	SIN		180	75	-
	021	43	RCL		101	65	×		181	43	RCL
	022	41	41		102	43	RCL		182	31	31
	023	85	+		103	44	44		183	33	X²
	024	43	RCL		104	95	=		184	95	=
	025	39	39		105	94	+/-		185	42	STO
	026	38	COS		106	42	STO		186	34	34
	027	65	×		107	33	33		187	43	RCL
	028	43	RCL		108	43	RCL		188	29	29
	029	44	44		109	27	27		189	65	×
	030	95	=		110	65	×		190	43	RCL
	031	42	STO		111	43	RCL		191	32	32
	032	40	40		112	28	28		192	75	-
	033	38	COS		113	65	×		193	43	RCL
	034	65	×		114	43	RCL		194	28	28
	035	43	RCL		115	30	30		195	65	×
	036	45	45		116	85	+		196	43	RCL
	037	95	=		117	43	RCL		197	31	31
	038	42	STO		118	29	29		198	95	=
	039	27	27		119	65	×		199	42	STO
	040	75	-		120	43	RCL		200	37	37
	041	43	RCL		121	31	31		201	43	RCL
	042	39	39		122	65	×		202	31	31
	043	38	COS		123	43	RCL		203	65	×
	044	65	×		124	32	32		204	43	RCL
	045	02	2		125	65	×		205	32	32
	046	65	×		126	02	2		206	75	-
	047	43	RCL		127	75	-		207	43	RCL
	048	44	44		128	43	RCL		208	29	29
	049	95	=		129	28	28		209	65	×
	050	42	STO		130	65	×		210	43	RCL
	051	28	28		131	43	RCL		211	30	30
	052	43	RCL		132	31	31		212	95	=
	053	42	42		133	33	X²		213	42	STO
	054	75	-		134	75	-		214	35	35
	055	43	RCL		135	43	RCL		215	43	RCL
	056	43	43		136	27	27		216	29	29
	057	75	-		137	65	×		217	65	×
	058	43	RCL		138	43	RCL		218	43	RCL
	059	40	40		139	32	32		219	31	31
	060	38	COS		140	33	X²		220	75	-
	061	65	×		141	75	-		221	43	RCL
	062	43	RCL		142	43	RCL		222	27	27
	063	45	45		143	30	30		223	65	×
	064	95	=		144	65	×		224	43	RCL
	065	42	STO		145	43	RCL		225	32	32
	066	29	29		146	29	29		226	95	=
	067	85	+		147	33	X²		227	42	STO
	068	02	2		148	95	=		228	38	38
	069	65	×		149	42	STO		229	43	RCL
	070	43	RCL		150	26	26	S_{ij}	230	26	26
	071	42	42	S_{ij}^*	151	43	RCL		231	35	1/X
	072	75	-		152	28	28		232	49	PRD
	073	43	RCL		153	65	×		233	33	33
	074	42	42		154	43	RCL		234	49	PRD
	075	95	=		155	30	30		235	34	34
	076	42	STO		156	75	-		236	49	PRD
	077	30	30		157	43	RCL		237	35	35
	078	43	RCL		158	32	32		238	49	PRD
	079	39	39		159	33	X²		239	36	36


σ_i
ϵ_i


$\epsilon_i(\theta)$
R

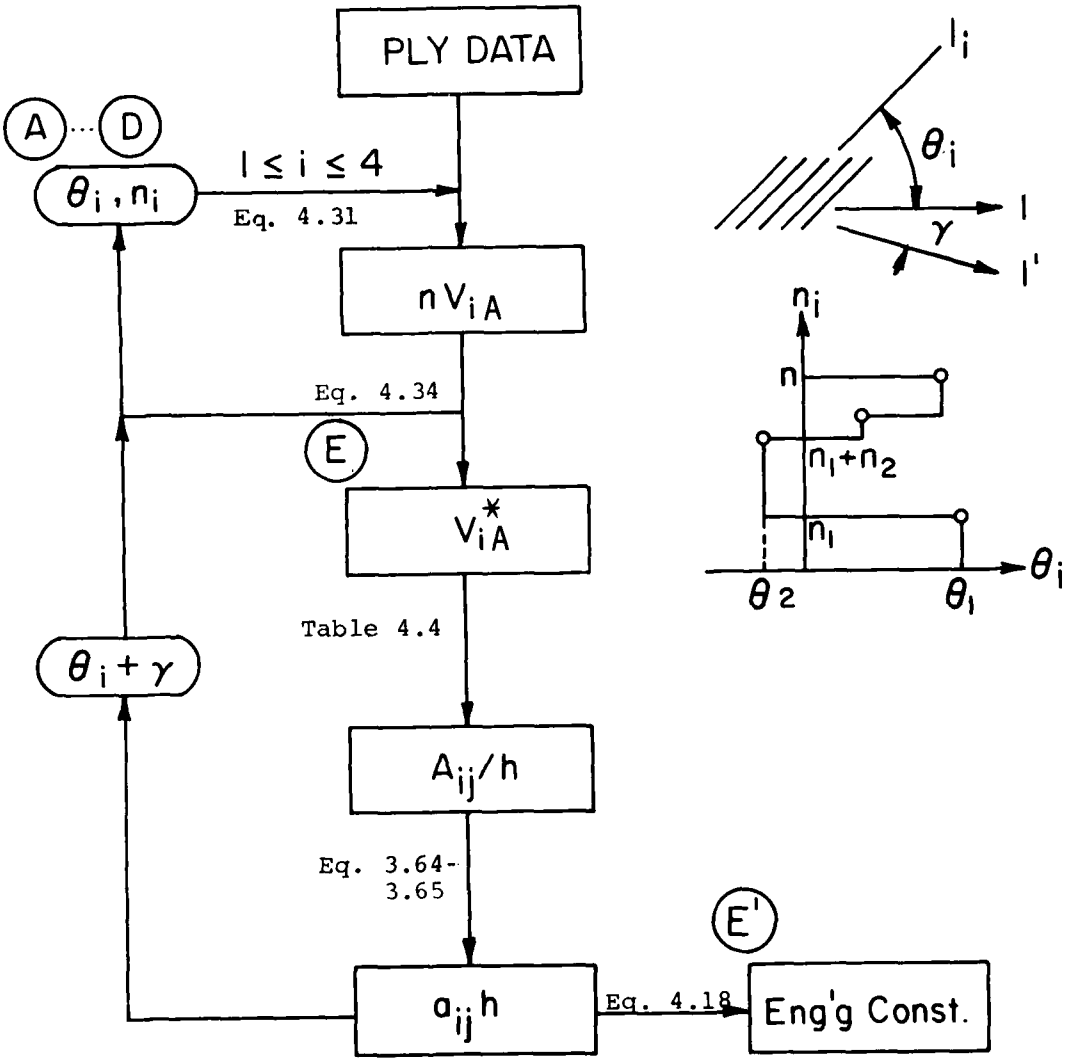

R'



θ	0. 00	15. 00	30. 00	45. 00	60. 00	75. 00	90. 00	
σ_i	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	01
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	02
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	03
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	04
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	05
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	06
	[illegible]	5.0511395-12	3.7563061-12	1.9868503-12	3.7563061-12	5.0511395-12	[illegible]	07
	[illegible]	9.0602066-12	33.111624-12	47.270209-12	33.111624-12	9.0602066-12	[illegible]	08
	0. 00	134.86750 12	-60.390288-12	-68.735007-12	-60.390288-12	134.86750 12	0. 00	09
	[illegible]	13.768628-12	34.746213-12	59.747083-12	34.746213-12	13.768628-12	[illegible]	10
	[illegible]	3.657202-12	-7.8776803-12	-9.987924-13	-7.8776803-12	3.657202-12	[illegible]	11
	0. 00	30.200717-12	-46.957821-12	-45.781256-12	-46.957821-12	30.200717-12	0. 00	12
	[illegible]	1.5 09	1.5 09	1.5 09	1.5 09	1.5 09	[illegible]	13
	[illegible]	1.5 09	1.5 09	1.5 09	1.5 09	1.5 09	[illegible]	14
	[illegible]	40. 06	40. 06	40. 06	40. 06	40. 06	[illegible]	15
	[illegible]	246. 06	246. 06	246. 06	246. 06	246. 06	[illegible]	16
	[illegible]	68. 06	68. 06	68. 06	68. 06	68. 06	[illegible]	17
	[illegible]	181. 09	181. 09	181. 09	181. 09	181. 09	[illegible]	18
	[illegible]	10.3 09	10.3 09	10.3 09	10.3 09	10.3 09	[illegible]	19
	[illegible]	280. -03	280. -03	280. -03	280. -03	280. -03	[illegible]	20
	[illegible]	.17 09	.17 09	.17 09	.17 09	.17 09	[illegible]	21
	[illegible]	10. -09	10. -09	10. -09	10. -09	10. -09	[illegible]	22
	[illegible]	12.5-06	12.5-06	12.5-06	12.5-06	12.5-06	[illegible]	23
	[illegible]	0. 00	0. 00	0. 00	0. 00	0. 00	[illegible]	24
	[illegible]	600. -03	600. -03	600. -03	600. -03	600. -03	[illegible]	25
Q_{ij}	[illegible]	11.426434 09	13.406434 09	13.426934 09	13.406434 09	11.426434 09	[illegible]	26
	[illegible]	160.46995 09	109.37435 09	56.657787 09	109.37435 09	160.46995 09	[illegible]	27
	[illegible]	11.976415 09	28.646757 09	56.657787 09	28.646757 09	11.976415 09	[illegible]	28
	[illegible]	12.75214 09	32.462571 09	42.317783 09	32.462571 09	12.75214 09	[illegible]	29
	[illegible]	17.025216 09	36.735647 09	46.590862 09	36.735647 09	17.025216 09	[illegible]	30
	0. 00	38.502857 09	54.192991 09	42.866245 09	54.192991 09	38.502857 09	0. 00	31
	0. 00	4.3633885 09	20.058523 09	42.866245 09	20.058523 09	4.3633885 09	0. 00	32
S_{ij}	[illegible]	13.768628-12	34.746213-12	59.747083-12	34.746213-12	13.768628-12	[illegible]	33
	[illegible]	93.064094-12	80.527471-12	59.747083-12	80.527471-12	93.064094-12	[illegible]	34
	[illegible]	-3.657202-12	-7.8776803-12	-9.987924-13	-7.8776803-12	-3.657202-12	[illegible]	35
	[illegible]	131.02905-12	114.14713-12	105.70616-12	114.14713-12	131.02905-12	[illegible]	36
	0. 00	-30.200717-12	-46.957821-12	-45.781256-12	-46.957821-12	-30.200717-12	0. 00	37
	0. 00	-15.580541-12	-32.337649-12	-45.781256-12	-32.337649-12	-15.580541-12	0. 00	38
	0. 00	30. 00	60. 00	90. 00	120. 00	150. 00	180. 00	39
	0. 00	60. 00	120. 00	90. 00	60. 00	30. 00	0. 00	40
	125. -06	125. -06	125. -06	125. -06	125. -06	125. -06	125. -06	41
	49.487787 09	49.487787 09	49.487787 09	49.487787 09	49.487787 09	49.487787 09	49.487787 09	42
	26.880431 09	26.880431 09	26.880431 09	26.880431 09	26.880431 09	26.880431 09	26.880431 09	43
	85.73249 09	85.73249 09	85.73249 09	85.73249 09	85.73249 09	85.73249 09	85.73249 09	44
	19.710431 09	19.710431 09	19.710431 09	19.710431 09	19.710431 09	19.710431 09	19.710431 09	45
	444.44444-21	444.44444-21	444.44444-21	444.44444-21	444.44444-21	444.44444-21	444.44444-21	46
	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	47
	101.62602-18	101.62602-18	101.62602-18	101.62602-18	101.62602-18	101.62602-18	101.62602-18	48
	20.934959-09	20.934959-09	20.934959-09	20.934959-09	20.934959-09	20.934959-09	20.934959-09	49
	-500. -03	-500. -03	-500. -03	-500. -03	-500. -03	-500. -03	-500. -03	50
	-3.3603243-18	-3.3603243-18	-3.3603243-18	-3.3603243-18	-3.3603243-18	-3.3603243-18	-3.3603243-18	51
R	1.5 09	322.22216 06	322.22462 06	64.586589 06	322.22462 06	322.22216 06	1.5 09	52
	1.5 09	322.82798 06	322.82552 06	64.586589 06	322.82552 06	322.82798 06	1.5 09	53
	12.004384 03	12.004384 03	12.004384 03	12.004384 03	12.004384 03	12.004384 03	12.004384 03	54
	10.680652 03	10.680652 03	10.680652 03	10.680652 03	10.680652 03	10.680652 03	10.680652 03	55
	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03	56
	11.117842 03	11.117842 03	11.117842 03	11.117842 03	11.117842 03	11.117842 03	11.117842 03	57
	60.646995 00	60.646995 00	60.646995 00	60.646995 00	60.646995 00	60.646995 00	60.646995 00	58
	216.59641 00	216.59641 00	216.59641 00	216.59641 00	216.59641 00	216.59641 00	216.59641 00	59

TAPE #3

IN-PLANE STIFFNESS OF SYMMETRIC LAMINATES



TAPE #3: IN-PLANE STIFFNESS OF SYMMETRIC LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Enter ply data.	--		
1	Enter ply angle θ_i, and number of plies at that angle, n_i^*, i=1,4, and calculate $V_{1A}^*, V_{2A}^*, V_{3A}^*$ and V_{4A}^* for each ply and sum them, and calculate n . Since $1 \leq i \leq 4$, values for nonexisting plies need not be entered, i.e. for a [0/90] laminate, i=3 and 4 can be skipped.	θ_1	A	θ_1
		n_1	R/S	$2n_1$
		θ_2	B	θ_2
		n_2	R/S	$2(n_1 + n_2)$
		θ_3	C	θ_3
		n_3	R/S	$2(n_1+n_2+n_3)$
		θ_4	D	θ_4
		n_4	R/S	n
2	Calculate V_{iA}, h, A_{ij}/h, and $a_{ij}h$.	--	E	1.00
3	Calculate engineering constants	--	E'	E_1^o
		--	R/S	E_2^o
		--	R/S	ν_{12}^o
		--	R/S	E_6^o
Alternative A				
1A	Rotate entire laminate by γ; **	γ	A'	$2n_1$
	n_i remain the same	--	B'	$2(n_1 + n_2)$
		--	C'	$2(n_1+n_2+n_3)$
		--	D'	n
2A	Calculate transformed A_{ij}/h and $a_{ij}h$.	--	E	1.00
3A	Calculate engineering constants	--	E'	E_1^o
		--	etc.	

* The number of plies n_i of each ply orientation are those in the upper half of the laminate. The total number for each orientation is $2n_i$. The thickness h in Register 26 is the total thickness of the laminate; the number in Register 46 is one half of the total ply number. For symmetric laminates, only the fraction of each orientation rather than the absolute number of plies is important. If more than four ply orientations are needed, additional θ and n can be entered through Key B, C or D; but not Key A which initializes the program.

** This is equivalent to rotating the reference coordinates in the clockwise or negative direction.

IN-PLANE STIFFNESS OF
SYMMETRIC LAMINATES

Tape# 3 Title

A' $\theta_1+\gamma$, n_1	B' $\theta_2+\gamma$, n_2	C' $\theta_3+\gamma$, n_3	D' $\theta_4+\gamma$, n_4	E' Eng'g Const.
A θ_1, n_1	B θ_2, n_2	C θ_3, n_3	D θ_4, n_4	E A^*_{ij}, a^*_{ij}

00 γ	15 θ_2	30 A_{66}/h	45 U_3
01	16 n_2	31 A_{16}/h	46 $n/2$
02	17 θ_3	32 A_{26}/h	47 V^*_{1A}
03	18 n_3	33 $a_{11}h$	48 V^*_{2A}
04	19 θ_4	34 $a_{22}h$	49 V^*_{3A}
05	20 n_4	35 $a_{12}h$	50 V^*_{4A}
06	21	36 $a_{66}h$	51
07	22	37 $a_{16}h$	52
08	23	38 $a_{26}h$	53
09	24	39 θ_i, $\|A\|$	54
10	25	40 n_i	55
11	26 h	41 h_o	56
12	27 A_{11}/h	42 $\frac{1}{2}(U_1+U_4)$	57
13 θ_1	28 A_{22}/h	43 $U_5=\frac{1}{2}(U_1-U_4)$	58
14 n_1	29 A_{12}/h	44 U_2	59

θ_1, n_1

000	76	LBL	
001	11	A	
002	51	ENG	
003	42	STO	
004	12	12	
005	00	0	
006	42	STO	
007	46	46	
008	42	STO	
009	47	47	
010	42	STO	
011	48	48	
012	42	STO	
013	49	49	
014	42	STO	
015	50	50	
016	43	RCL	
017	13	13	
018	91	R/S	
019	42	STO	
020	14	14	
021	42	STO	
022	40	40	
023	44	SUM	
024	46	46	
025	43	RCL	
026	13	13	
027	71	SBR	
028	30	30	

θ_2, n_2

029	76	LBL	
030	12	B	
031	42	STO	
032	15	15	
033	91	R/S	
034	42	STO	
035	16	16	
036	42	STO	
037	40	40	
038	44	SUM	
039	46	46	
040	43	RCL	
041	15	15	
042	71	SBR	
043	30	30	

θ_3, n_3

044	76	LBL	
045	13	C	
046	42	STO	
047	17	17	
048	91	R/S	
049	42	STO	
050	18	18	
051	42	STO	
052	40	40	
053	44	SUM	
054	46	46	
055	43	RCL	
056	17	17	
057	71	SBR	
058	30	30	

θ_4, n_4

059	76	LBL	
060	14	D	
061	42	STO	
062	19	19	
063	91	R/S	
064	42	STO	
065	20	20	
066	42	STO	
067	40	40	
068	44	SUM	
069	46	46	
070	43	RCL	
071	19	19	

V_{iA}

072	76	LBL	
073	11	A	
074	65	×	
075	02	2	
076	95	=	
077	94	+ -	
078	42	STO	
079	39	39	
080	39	COS	
081	65	×	
082	43	RCL	
083	40	40	
084	95	=	
085	44	SUM	
086	47	47	
087	43	RCL	
088	11	A	
089	01	1	
090	65	×	
091	43	RCL	
092	40	40	
093	95	=	
094	44	SUM	
095	48	48	
096	01	1	
097	44	SUM	
098	01	1	
099	43	RCL	
100	01	1	
101	01	COS	
102	65	×	
103	43	RCL	
104	47	47	
105	95	=	
106	44	SUM	
107	49	49	
108	43	RCL	
109	39	39	
110	03	SIN	
111	65	×	
112	43	RCL	
113	40	40	
114	95	=	
115	44	SUM	
116	50	50	
117	43	RCL	
118	46	46	
119	65	×	
120	02	2	
121	95	=	
122	91	R/S	

V_{iA}^*

123	76	LBL	
124	15	E	
125	01	1	
126	03	3	
127	66	PAU	
128	43	RCL	
129	46	46	
130	95	=	
131	49	PRD	
132	47	47	
133	49	PRD	
134	48	48	
135	49	PRD	
136	49	49	
137	49	PRD	
138	50	50	
139	95	=	
140	65	×	
141	43	RCL	
142	41	41	
143	65	×	
144	02	2	
145	95	=	
146	42	STO	
147	26	26	

A_{ij}/h

148	43	RCL	
149	42	42	
150	85	+	
151	43	RCL	
152	43	43	
153	85	+	
154	43	RCL	
155	47	47	
156	65	×	
157	43	RCL	
158	44	44	
159	85	+	
160	43	RCL	
161	48	48	
162	65	×	
163	43	RCL	
164	45	45	
165	95	=	
166	42	STO	
167	27	27	
168	75	-	
169	02	2	
170	65	×	
171	43	RCL	
172	43	43	
173	65	×	
174	43	RCL	
175	44	44	
176	95	=	
177	42	STO	
178	28	28	
179	43	RCL	
180	42	42	
181	75	-	
182	43	RCL	
183	43	43	
184	75	-	
185	43	RCL	
186	48	48	
187	65	×	
188	43	RCL	
189	45	45	
190	95	=	
191	42	STO	
192	29	29	
193	75	-	
194	43	RCL	
195	42	42	
196	85	+	
197	02	2	
198	65	×	
199	43	RCL	
200	43	43	
201	95	=	
202	42	STO	
203	30	30	
204	43	RCL	
205	49	49	
206	65	×	
207	43	RCL	
208	44	44	
209	55	÷	
210	02	2	
211	85	+	
212	43	RCL	
213	50	50	
214	55	÷	
215	43	RCL	
216	45	45	
217	95	=	
218	44	+	
219	42	STO	
220	31	31	
221	85	+	
222	02	2	
223	55	÷	
224	43	RCL	
225	50	50	
226	65	×	
227	43	RCL	
228	45	45	
229	95	=	
230	42	STO	
231	32	32	

$|A|$

232	43	RCL	
233	27	27	
234	55	÷	
235	43	RCL	
236	28	28	
237	65	×	
238	43	RCL	
239	30	30	

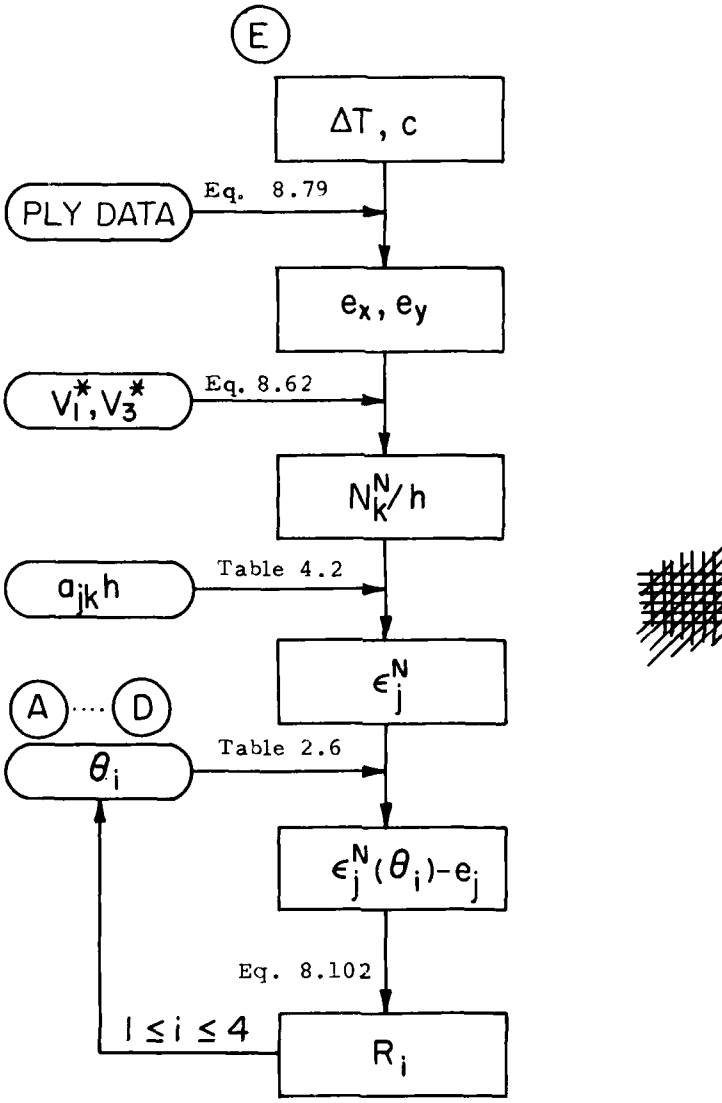
	240	85	+
	241	43	RCL
	242	29	29
	243	65	×
	244	43	RCL
	245	31	31
	246	65	×
	247	43	RCL
	248	32	32
	249	65	×
	250	02	2
	251	75	-
	252	43	RCL
	253	28	28
	254	65	×
	255	43	RCL
	256	31	31
	257	33	X²
	258	75	-
	259	43	RCL
	260	27	27
	261	65	×
	262	43	RCL
	263	32	32
	264	33	X²
	265	75	-
	266	43	RCL
	267	30	30
	268	65	×
	269	43	RCL
	270	29	29
	271	33	X²
	272	95	=
	273	42	STO
	274	39	39
$a_{ij}^* \lvert A \rvert$	275	43	RCL
	276	28	28
	277	65	×
	278	43	RCL
	279	30	30
	280	75	-
	281	43	RCL
	282	32	32
	283	33	X²
	284	95	=
	285	42	STO
	286	33	33
	287	43	RCL
	288	27	27
	289	65	×
	290	43	RCL
	291	28	28
	292	75	-
	293	43	RCL
	294	29	29
	295	33	X²
	296	95	=
	297	42	STO
	298	36	36
	299	43	RCL
	300	27	27
	301	65	×
	302	43	RCL
	303	30	30
	304	75	-
	305	43	RCL
	306	31	31
	307	33	X²
	308	95	=
	309	42	STO
	310	34	34
	311	43	RCL
	312	29	29
	313	65	×
	314	43	RCL
	315	32	32
	316	75	-
	317	43	RCL
	318	28	28
	319	65	×

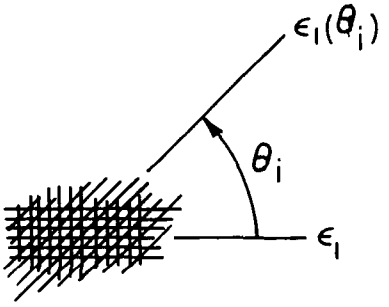
	320	43	RCL
	321	31	31
	322	95	=
	323	42	STO
	324	37	37
	325	43	RCL
	326	31	31
	327	65	×
	328	43	RCL
	329	32	32
	330	75	-
	331	43	RCL
	332	29	29
	333	65	×
	334	43	RCL
	335	30	30
	336	95	=
	337	42	STO
	338	35	35
	339	43	RCL
	340	29	29
	341	65	×
	342	43	RCL
	343	31	31
	344	75	-
	345	43	RCL
	346	27	27
	347	65	×
	348	43	RCL
	349	32	32
	350	95	=
	351	42	STO
	352	38	38
$a_{ij}h$	353	43	RCL
	354	39	39
	355	35	1/X
	356	49	PRD
	357	33	33
	358	49	PRD
	359	34	34
	360	49	PRD
	361	35	35
	362	49	PRD
	363	36	36
	364	49	PRD
	365	37	37
	366	49	PRD
	367	38	38
	368	01	1
	369	95	=
	370	91	R/S
	371	76	LBL
Eng'g Const.	372	10	E'
	373	43	RCL
	374	33	33
	375	35	1/X
	376	91	R/S
	377	43	RCL
	378	34	34
	379	35	1/X
	380	91	R/S
	381	43	RCL
	382	35	35
	383	55	÷
	384	43	RCL
	385	33	33
	386	95	=
	387	94	+/-
	388	91	R/S
	389	43	RCL
	390	36	36
	391	35	1/X
	392	91	R/S
$\theta_1 + \gamma$	393	76	LBL
	394	16	A'
	395	42	STO
	396	00	00
	397	44	SUM
	398	13	13
	399	44	SUM

	400	15	15
	401	44	SUM
	402	17	17
	403	44	SUM
	404	19	19
	405	00	0
	406	42	STO
	407	46	46
	408	42	STO
	409	47	47
	410	42	STO
	411	48	48
	412	42	STO
	413	49	49
	414	42	STO
	415	50	50
	416	43	RCL
	417	14	14
	418	42	STO
	419	40	40
	420	44	SUM
	421	46	46
	422	43	RCL
	423	13	13
	424	71	SBR
	425	33	X²
$\theta_2 + \gamma$	426	76	LBL
	427	17	B'
	428	43	RCL
	429	16	16
	430	42	STO
	431	40	40
	432	44	SUM
	433	46	46
	434	43	RCL
	435	15	15
	436	71	SBR
	437	33	X²
$\theta_3 + \gamma$	438	76	LBL
	439	18	C'
	440	43	RCL
	441	18	18
	442	42	STO
	443	40	40
	444	44	SUM
	445	46	46
	446	43	RCL
	447	17	17
	448	71	SBR
	449	33	X²
$\theta_4 + \gamma$	450	76	LBL
	451	19	D'
	452	43	RCL
	453	20	20
	454	42	STO
	455	40	40
	456	44	SUM
	457	46	46
	458	43	RCL
	459	19	19
	460	71	SBR
	461	33	X²
	462	00	0
	463	00	0
	464	00	0
	465	00	0
	466	00	0
	467	00	0
	468	00	0
	469	00	0
	470	00	0
	471	00	0
	472	00	0
	473	00	0
	474	00	0
	475	00	0
	476	00	0
	477	00	0
	478	00	0
	479	00	0

	0.	00	00	0.	00	00	0.	00	00	0.	00	00
	181.81114	09	01	181.81114	09	01	181.81114	09	01	181.81114	09	01
	10.346159	09	02	10.346159	09	02	10.346159	09	02	10.346159	09	02
	2.8869244	09	03	2.8869244	09	03	2.8869244	09	03	2.8869244	09	03
	0.	00	04	0.	00	04	0.	00	04	0.	00	04
	0.	00	05	0.	00	05	0.	00	05	0.	00	05
	0.	00	06	0.	00	06	0.	00	06	0.	00	06
	0.	00	07	0.	00	07	0.	00	07	0.	00	07
	0.	00	08	0.	00	08	0.	00	08	0.	00	08
	0.	00	09	0.	00	09	0.	00	09	0.	00	09
	0.	00	10	0.	00	10	0.	00	10	0.	00	10
	0.	00	11	0.	00	11	0.	00	11	0.	00	11
	0.	00	12	0.	00	12	0.	00	12	0.	00	12
θ_i	0.	00	13	45.	00	13	0.	00	13	0.	00	13
	1.	00	14	1.	00	14	1.	00	14	1.	00	14
n_i	90.	00	15	-45.	00	15	60.	00	15	90.	00	15
	1.	00	16	1.	00	16	1.	00	16	1.	00	16
	68.	06	17	68.	06	17	-60.	00	17	45.	00	17
	181.	09	18	181.	09	18	1.	00	18	1.	00	18
	10.3	09	19	10.3	09	19	10.3	09	19	-45.	00	19
	380.-03		20	380.-03		20	380.-03		20	1.	00	20
	7.17	09	21	7.17	09	21	7.17	09	21	7.17	09	21
	10.-09		22	10.-09		22	10.-09		22	10.-09		22
	12.5-06		23	12.5-06		23	12.5-06		23	12.5-06		23
	0.	00	24	0.	00	24	0.	00	24	0.	00	24
	600.-03		25	600.-03		25	600.-03		25	600.-03		25
h	500.-06		26	500.-06		26	750.-06		26	1.-03		26
	96.078648	09	27	56.657787	09	27	76.368218	09	27	76.368218	09	27
	96.078648	09	28	56.657787	09	28	76.368218	09	28	76.368218	09	28
A_{ij}/h	2.8869244	09	29	42.317787	09	29	22.607356	09	29	22.607356	09	29
	7.17	09	30	46.590862	09	30	26.880431	09	30	26.880431	09	30
	0.	00	31	0.	00	31	0.	00	31	0.	00	31
	0.	00	32	0.	00	32	0.	00	32	0.	00	32
	10.417611	-12	33	39.919255	-12	33	14.352198	-12	33	14.352198	-12	33
$a_{ij}h$	10.417611	-12	34	39.919255	-12	34	14.352198	-12	34	14.352198	-12	34
	-814.10757	-15	35	-29.815752	-12	35	-4.2486946	-12	35	-4.2486946	-12	35
	139.47001	-12	36	21.463436	-12	36	37.201784	-12	36	37.201784	-12	36
	0.	00	37	0.	00	37	0.	00	37	0.	00	37
	0.	00	38	0.	00	38	0.	00	38	0.	00	38
	66.126864	30	39	66.126864	30	39	143.0311	30	39	143.0311	30	39
	1.	00	40	1.	00	40	1.	00	40	1.	00	40
	125.	-06	41	125.	-06	41	125.	-06	41	125.	-06	41
	49.487787	09	42	49.487787	09	42	49.487787	09	42	49.487787	09	42
	26.880431	09	43	26.880431	09	43	26.880431	09	43	26.880431	09	43
	85.73249	09	44	85.73249	09	44	85.73249	09	44	85.73249	09	44
	19.710431	09	45	19.710431	09	45	19.710431	09	45	19.710431	09	45
	2.	00	46	2.	00	46	3.	00	46	4.	00	46
	0.	00	47	0.	00	47	433.33333	-15	47	0.	00	47
	1.	00	48	-1.	00	48	-733.33333	-15	48	0.	00	48
	0.	00	49	0.	00	49	0.	00	49	0.	00	49
	0.	00	50	0.	00	50	0.	00	50	0.	00	50
	-3.3603243	-18	51	-3.3603243	-18	51	-3.3603243	-18	51	-3.3603243	-18	51
	0.	00	52	0.	00	52	0.	00	52	0.	00	52
	0.	00	53	0.	00	53	0.	00	53	0.	00	53
	12.004384	03	54	12.004384	03	54	12.004384	03	54	12.004384	03	54
	10.680652	03	55	10.680652	03	55	10.680652	03	55	10.680652	03	55
	-3.0691032	03	56	-3.0691032	03	56	-3.0691032	03	56	-3.0691032	03	56
	11.117842	03	57	11.117842	03	57	11.117842	03	57	11.117842	03	57
	60.646995	00	58	60.646995	00	58	60.646995	00	58	60.646995	00	58
	216.59641	00	59	216.59641	00	59	216.59641	00	59	216.59641	00	59

TAPE #4
IN-PLANE NON MECHANICAL STRAINS OF SYMMETRIC LAMINATES





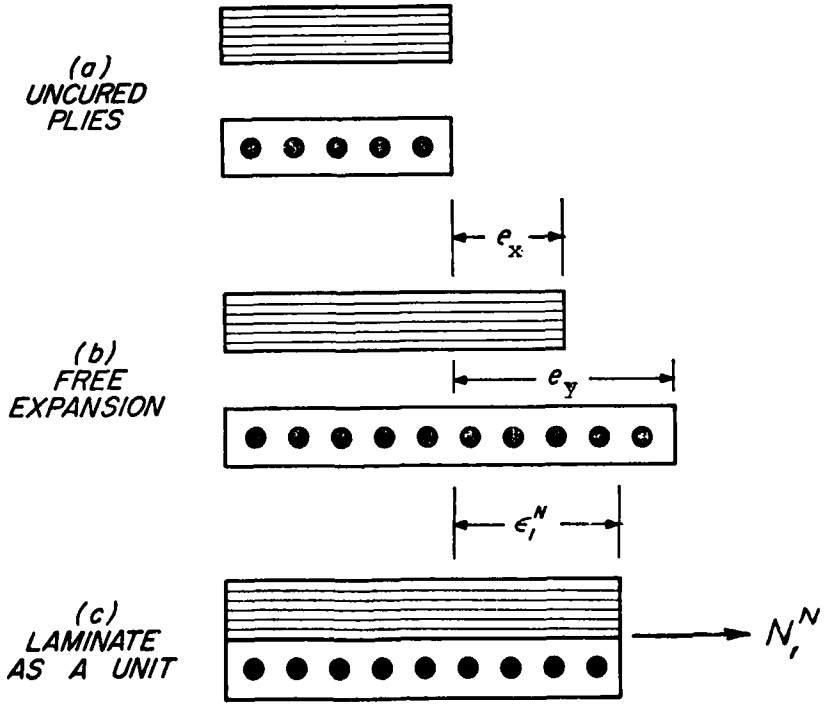
USER INSTRUCTIONS

TAPE #4: IN-PLANE NONMECHANICAL STRAINS OF SYMMETRIC LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Data from Tape #3 must be in storage.*	--		--
1	Enter ΔT, and c and calculate ϵ_j^N	ΔT	E	ΔT
		c	R/S	1.00
2**	Calculate nonmechanical strains and the strength ratios R_i for each layer, i=1-4.	--	A	R_1
	The strengths are based on the combination of environmentally induced strains from both temperature and moisture.	--	B	R_2
		--	C	R_3
		--	D	R_4

* Data in Registers 47 and 49 are needed for this Tape.

** This step is not necessary for the strength calculations in subsequent tapes. In fact, only side 1 of this tape (program steps 000 - 166) need to be entered. The nonmechanical strength ratio indicates the temperature and/or moisture level that would induce ply failures.



Tape# 4 Title IN-PLANE NONMECHANICAL STRAINS OF SYMMETRIC LAMINATES

A'	B'	C'	D'	E'
A R_1	B R_2	C R_3	D R_4	E ΔT, c
00 γ	15 θ_2	30 R_1	45 U_3	
01 Q_{xx}	16 n_2	31 R_2	46 n	
02 Q_{yy}	17 θ_3	32 R_3	47 V^*_{1A}	
03 Q_{xy}	18 n_3	33 $a_{11}h$	48 V^*_{2A}, ΔT	
04 N^N_1/h	19 θ_4	34 $a_{22}h$	49 V^*_{3A}	
05 N^N_2/h	20 n_4	35 $a_{12}h$	50 V^*_{4A}, c	
06 N^N_6/h	21 $2\theta_i$	36 $a_{66}h$	51	
07 $e^N_1(\theta_i)-e_x$	22 α_x	37 $a_{16}h$	52 e_x	
08 $e^N_2(\theta_i)-e_y$	23 α_y	38 $a_{26}h$	53 e_y	
09 $e^N_6(\theta_i)$	24 β_x	39 $\ldots R'_4$	54 G_{xx}	
10 e^N_1	25 β_y	40 $\ldots R_4$	55 G_{yy}	
11 e^N_2	26 h	41	56 G_{xy}	
12 e^N_6	27 R'_1	42 $\frac{1}{2}(U_1+U_4)$	57 G_{ss}	
13 θ_1	28 R'_2	43 $U_5=\frac{1}{2}(U_1-U_4)$	58 G_x	
14 n_1	29 R'_3	44 U_2	59 G_y	

N_K^N/h

```
000  76 LBL
001  15  E
002  57 ENG
010  24  24
011  85  +
012  43 RCL
013  48  48
014  65  ×
015  43 RCL
016  22  22
017  95  =
018  42 STO
019  52  52
020  08  8
021  66 PAU
022  43 RCL
023  48  48
024  65  ×
025  43 RCL
026  23  23
027  85  +
028  43 RCL
029  50  50
030  65  ×
031  43 RCL
032  25  25
033  95  =
034  42 STO
035  53  53
036  65  ×
037  43 RCL
038  03  03
039  85  +
040  43 RCL
041  52  52
042  65  ×
043  43 RCL
044  01  01
045  95  =
046  42 STO
047  39  39
048  43 RCL
049  52  52
050  65  ×
051  43 RCL
052  03  03
053  85  +
054  43 RCL
055  53  53
056  65  ×
057  43 RCL
058  02  02
059  95  =
060  42 STO
061  40  40
062  85  +
063  43 RCL
064  39  39
065  95  =
066  55  -
067  02  2
068  95  =
069  42 STO
070  39  39
071  75  -
072  43 RCL
073  40  40
074  95  =
075  42 STO
076  40  40
077  65  ×
078  43 RCL
079  47  47
```

ε_j^N

```
080  85  +
081  43 RCL
082  39  39
083  95  =
084  42 STO
085  04  04
086  75  -
087  02  2
088  65  ×
089  43 RCL
090  47  47
091  65  ×
092  43 RCL
093  40  40
094  95  =
095  42 STO
096  05  05
097  43 RCL
098  49  49
099  65  ×
100  43 RCL
101  40  40
102  95  =
103  94 +/-
104  42 STO
105  06  06
106  65  ×
107  43 RCL
108  37  37
109  85  +
110  43 RCL
111  04  04
112  65  ×
113  43 RCL
114  33  33
115  85  +
116  43 RCL
117  05  05
118  65  ×
119  43 RCL
120  35  35
121  95  =
122  42 STO
123  10  10
124  43 RCL
125  04  04
126  65  ×
127  43 RCL
128  35  35
129  85  +
130  43 RCL
131  05  05
132  65  ×
133  43 RCL
134  34  34
135  85  +
136  43 RCL
137  06  06
138  65  ×
139  43 RCL
140  38  38
141  95  =
142  42 STO
143  11  11
144  43 RCL
145  04  04
146  65  ×
147  43 RCL
148  37  37
149  85  +
150  43 RCL
151  05  05
152  65  ×
153  43 RCL
154  38  38
155  85  +
156  43 RCL
157  06  06
158  65  ×
159  43 RCL
```

```
160  36  36
161  95  =
162  42 STO
163  12  12
164  01  1
165  95  =
166  91 R/S
```

R_1

```
167  76 LBL
168  11  A
169  43 RCL
170  13  13
171  71 SBR
172  35 1/X
173  42 STO
174  27  27
175  43 RCL
176  40  40
177  42 STO
178  30  30
179  91 R/S
```

R_2

```
180  76 LBL
181  12  B
182  43 RCL
183  15  15
184  71 SBR
185  35 1/X
186  42 STO
187  28  28
188  43 RCL
189  40  40
190  42 STO
191  31  31
192  91 R/S
```

R_3

```
193  76 LBL
194  13  C
195  43 RCL
196  17  17
197  71 SBR
198  35 1/X
199  42 STO
200  29  29
201  43 RCL
202  40  40
203  42 STO
204  32  32
205  91 R/S
```

R_4

```
206  76 LBL
207  14  D
208  43 RCL
209  19  19
210  71 SBR
211  35 1/X
212  42 STO
213  39  39
214  43 RCL
215  40  40
216  91 R/S
```

$\varepsilon_j^N(\theta_i) - e_j$

```
217  76 LBL
218  35 1/X
219  65  ×
220  02  2
221  95  =
222  42 STO
223  21  21
224  01  1
225  00  0
226  66 PAU
227  43 RCL
228  10  10
229  85  +
230  43 RCL
231  11  11
232  95  =
233  55  -
234  02  2
235  95  =
236  42 STO
237  39  39
238  75  -
239  43 RCL
```

240	11	11	320	07	07
241	95	=	321	65	×
242	42	STO	322	43	RCL
243	40	40	323	08	08
244	65	×	324	85	+
245	43	RCL	325	43	RCL
246	21	21	326	55	55
247	39	COS	327	65	×
248	85	+	328	43	RCL
249	43	RCL	329	08	08
250	39	39	330	33	X^2
251	85	+	331	95	=
252	53	(	332	42	STO
253	43	RCL	333	39	39
254	12	12	334	43	RCL
255	65	×	335	58	58
256	43	RCL	336	65	×
257	21	21	337	43	RCL
258	38	SIN	338	07	07
259	54	)	339	85	+
260	55	÷	340	43	RCL
261	02	2	341	59	59
262	75	-	342	65	×
263	43	RCL	343	43	RCL
264	52	52	344	08	08
265	95	=	345	95	=
266	42	STO	346	55	÷
267	07	07	347	43	RCL
268	75	-	348	39	39
269	43	RCL	349	55	÷
270	10	10	350	02	2
271	75	-	351	95	=
272	43	RCL	352	42	STO
273	11	11	353	40	40
274	85	+	354	33	X^2
275	43	RCL	355	85	+
276	52	52	356	43	RCL
277	85	+	357	39	39
278	43	RCL	358	35	1/X
279	53	53	359	95	=
280	95	=	360	34	$\sqrt{X}$
281	94	+/-	361	42	STO
282	42	STO	362	39	39
283	08	08	363	75	-
284	43	RCL	364	43	RCL
285	12	12	365	40	40
286	65	×	366	95	=
287	43	RCL	367	42	STO
288	21	21	368	40	40
289	39	COS	369	75	-
290	75	-	370	02	2
291	43	RCL	371	65	×
292	40	40	372	43	RCL
293	65	×	373	39	39
294	02	2	374	95	=
295	65	×	375	94	+/-
296	43	RCL	376	92	RTN
297	21	21			
298	38	SIN			
299	95	=			
300	42	STO			
301	09	09			
302	33	X^2			
303	65	×			
304	43	RCL			
305	57	57			
306	85	+			
307	43	RCL			
308	54	54			
309	65	×			
310	43	RCL			
311	07	07			
312	33	X^2			
313	85	+			
314	02	2			
315	65	×			
316	43	RCL			
317	56	56			
318	65	×			
319	43	RCL			

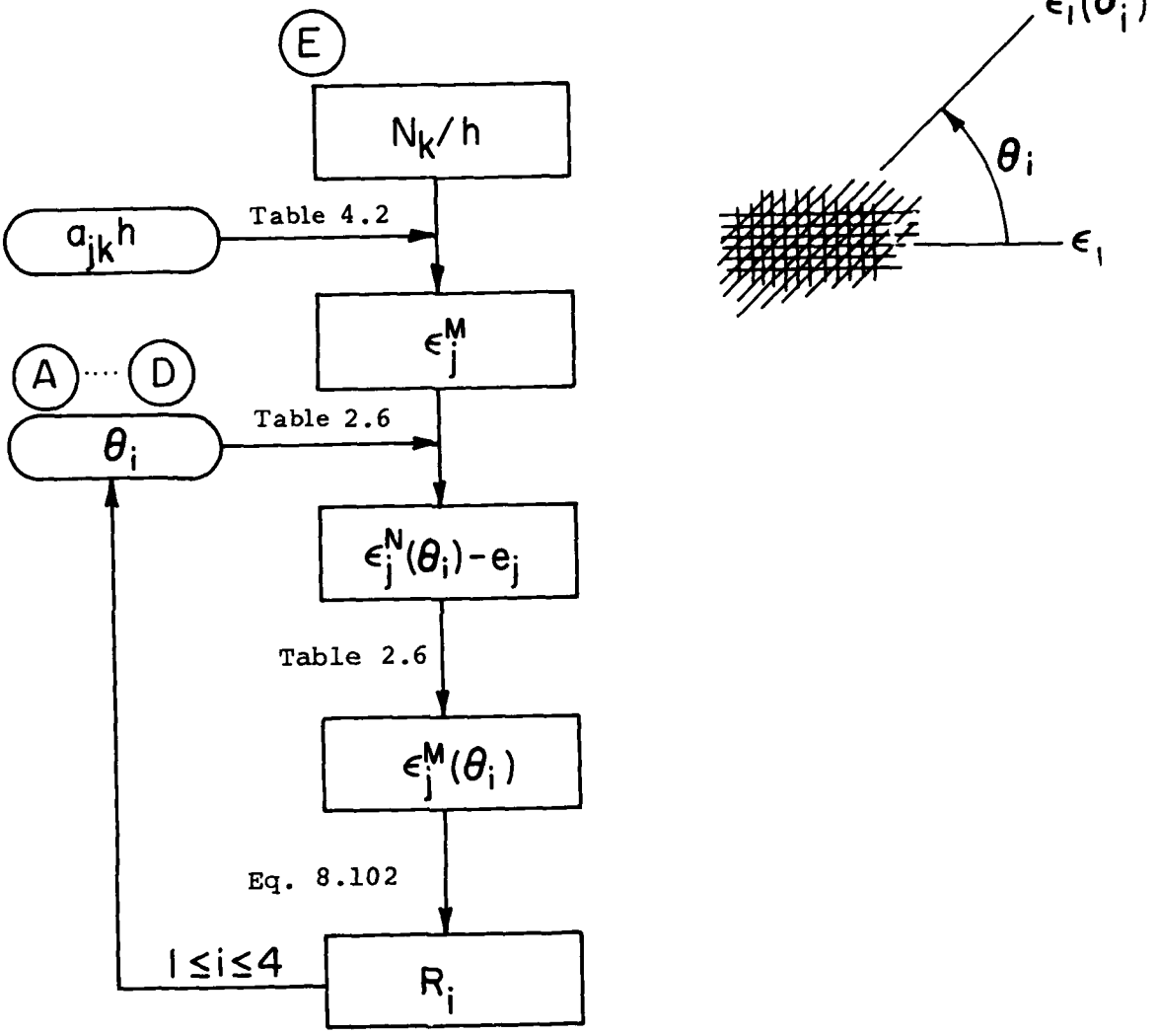
R_i

	0. 00	00
	181.81114 09	01
	10.346159 09	02
	2.8969244 09	03
	-12.553922 06	04
	-12.553922 06	05
	0. 00	06
	-125.33858-06	07
	1.7481614-03	08
	0. 00	09
	-126.83858-06	10
	-126.83858-06	11
	0. 00	12
θ_i	0. 00	13
	1. 00	14
n_i	90. 00	15
	1. 00	16
	68. 06	17
	181. 09	18
	10.3 09	19
	280. -03	20
	180. 00	21
	10. -09	22
	12.5-06	23
	0. 00	24
	600. -03	25
	500. -06	26
	13.092402 00	27
	13.092402 00	28
	2.8969244 09	29
	2.2350152 00	30
	2.2350152 00	31
	0. 00	32
	10.417611-12	33
	10.417611-12	34
	-314.10757-15	35
	139.47001-12	36
	0. 00	37
	0. 00	38
	7.6637088 00	39
	2.2350152 00	40
	125. -06	41
	49.487787 09	42
	26.880431 09	43
	85.73249 09	44
	19.710431 09	45
	2. 00	46
	0. 00	47
ΔT	-150. 00	48
	0. 00	49
c	0. 00	50
	-3.3603243-18	51
	-1.5-06	52
	-1.875-03	53
	12.004384 03	54
	10.680652 03	55
	-3.0691032 03	56
	11.117842 03	57
	60.646995 00	58
	216.59641 00	59

	0. 00	00
	181.81114 09	01
	10.346159 09	02
	2.8969244 09	03
	19.864625 06	04
	19.864625 06	05
	0. 00	06
	200.7023-06	07
	-2.7992977-03	08
	0. 00	09
	200.7023-06	10
	200.7023-06	11
	0. 00	12
	0. 00	13
	1. 00	14
	90. 00	15
	1. 00	16
	68. 06	17
	181. 09	18
	10.3 09	19
	280. -03	20
	180. 00	21
	10. -09	22
	12.5-06	23
	0. 00	24
	600. -03	25
	500. -06	26
	1.395767 00	27
	1.395767 00	28
	2.8969244 09	29
	8.1762053 00	30
	8.1762053 00	31
	0. 00	32
	10.417611-12	33
	10.417611-12	34
	-314.10757-15	35
	139.47001-12	36
	0. 00	37
	0. 00	38
	4.7859861 00	39
	8.1762053 00	40
	125. -06	41
	49.487787 09	42
	26.880431 09	43
	85.73249 09	44
	19.710431 09	45
	2. 00	46
	0. 00	47
	0. 00	48
	0. 00	49
	5. -03	50
	-3.3603243-18	51
	0. 00	52
	3. -03	53
	12.004384 03	54
	10.680652 03	55
	-3.0691032 03	56
	11.117842 03	57
	60.646995 00	58
	216.59641 00	59

	0. 00	00
	181.81114 09	01
	10.346159 09	02
	2.8969244 09	03
	7.3107032 06	04
	7.3107032 06	05
	0. 00	06
	75.363712-06	07
	-1.0511363-03	08
	0. 00	09
	73.863712-06	10
	73.863712-06	11
	0. 00	12
	0. 00	13
	1. 00	14
	90. 00	15
	1. 00	16
	68. 06	17
	181. 09	18
	10.3 09	19
	280. -03	20
	180. 00	21
	10. -09	22
	12.5-06	23
	0. 00	24
	600. -03	25
	500. -06	26
	3.7170891 00	27
	3.7170891 00	28
	2.8969244 09	29
	21.774182 00	30
	21.774182 00	31
	0. 00	32
	10.417611-12	33
	10.417611-12	34
	-314.10757-15	35
	139.47001-12	36
	0. 00	37
	0. 00	38
	12.745636 00	39
	21.774182 00	40
	125. -06	41
	49.487787 09	42
	26.880431 09	43
	85.73249 09	44
	19.710431 09	45
	2. 00	46
	0. 00	47
	-150. 00	48
	0. 00	49
	5. -03	50
	-3.3603243-18	51
	-1.5-06	52
	1.125-03	53
	12.004384 03	54
	10.680652 03	55
	-3.0691032 03	56
	11.117842 03	57
	60.646995 00	58
	216.59641 00	59

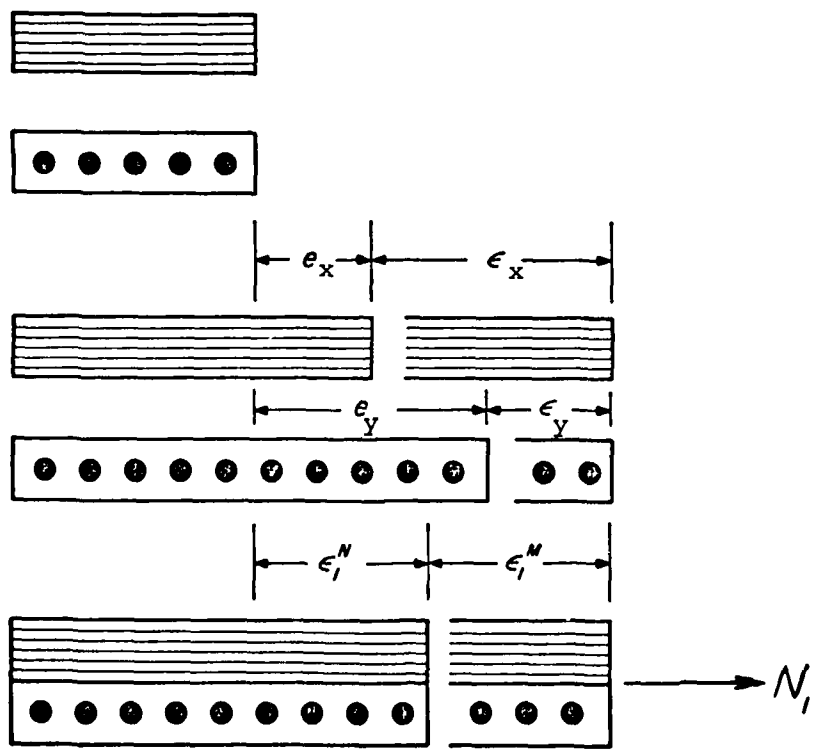
TAPE #5
IN-PLANE STRENGTH OF SYMMETRIC LAMINATES



TAPE #5: IN-PLANE STRENGTH OF SYMMETRIC LAMINATES

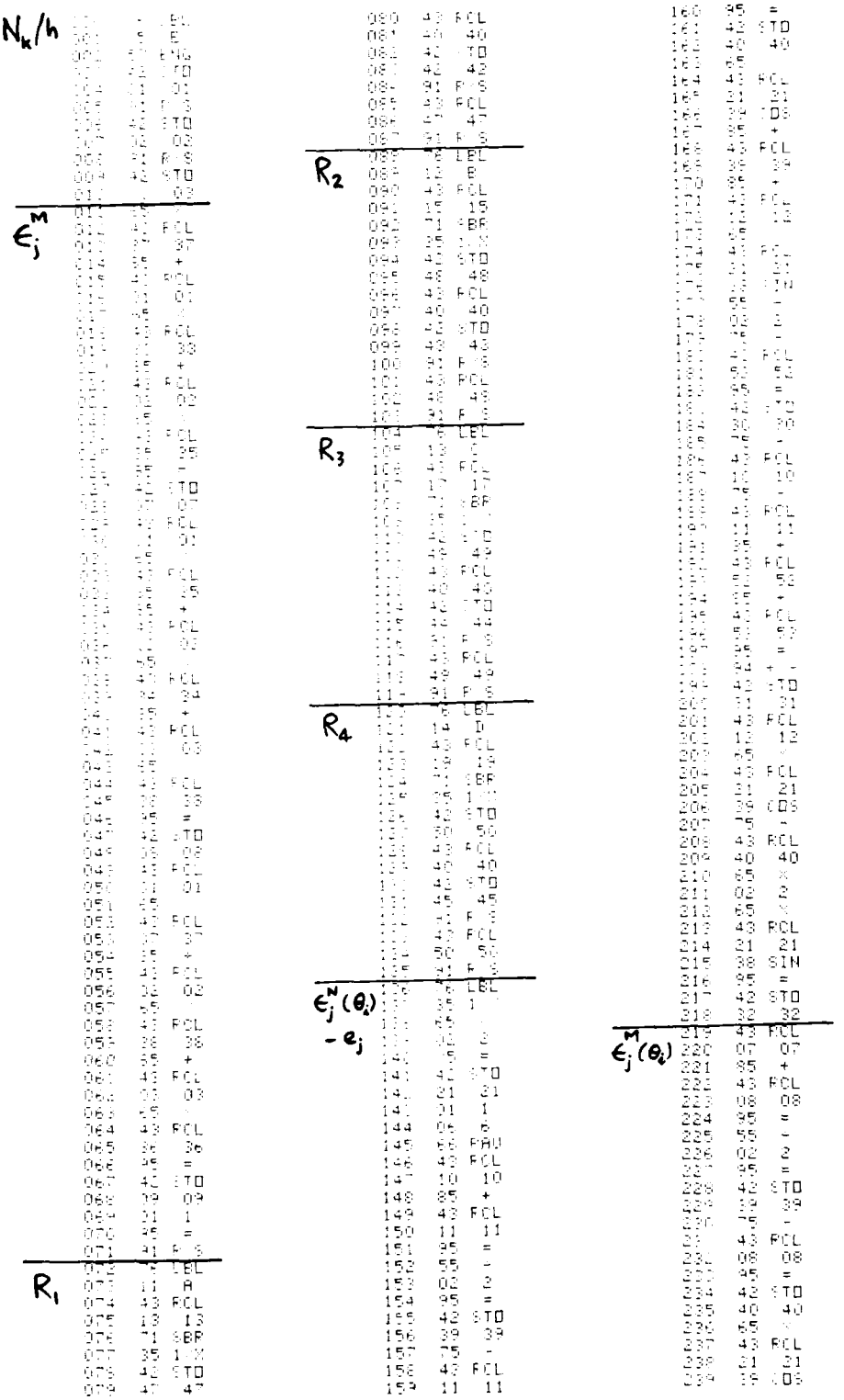
STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results from Tape #3, or #3 and #4 must be in storage*	--		--
1	Enter N_k components and calculate e_j^M. Unit stresses such as [1,0,0] can be entered here. The resulting S values are the allowables.	N_1/h	E	N_1/h
		N_2/h	R/S	N_2/h
		N_6/h	R/S	1.00
2	Calculate strength ratios R_i & R_i' for each layer, i=1-4. These strengths are based on the ratios of mechanical strains; not the total strains.	--	A	R_1
		--	B	R_2
		--	C	R_3
		--	D	R_4

*Tape #5 can be used following Tape #3 if nonmechanical strains are neglected. Ply data tape used in Step 0 of Tape #3 automatically make $e_x = e_y = 0$. Tape #4 need not be run for making $\Delta T = c = 0$.



Tape# 5 Title IN-PLANE STRENGTH OF SYMMETRIC LAMINATES

A'		B'		C'		D'		E'	
A	R_1	B	R_2	C	R_3	D	R_4	E	N_k/h, ϵ_j^M
00		15	θ_2	30	$\epsilon_1^N(\theta_i)-e_x$	45	R_4		
01	N_1/h	16		31	$\epsilon_2^N(\theta_i)-e_y$	46			
02	N_2/h	17	θ_3	32	$\epsilon_6^N(\theta_i)$	47	R'_1		
03	N_6/h	18		33	$a_{11}h$	48	R'_2		
04		19	θ_4	34	$a_{22}h$	49	R'_3		
05		20		35	$a_{12}h$	50	R'_4		
06		21	$2\theta_i$	36	$a_{66}h$	51			
07	ϵ_1^M	22		37	$a_{16}h$	52	e_x		
08	ϵ_2^M	23		38	$a_{26}h$	53	e_y		
09	ϵ_6^M	24		39		54	G_{xx}		
10	ϵ_1^N	25		40		55	G_{yy}		
11	ϵ_2^N	26		41		56	G_{xy}		
12	ϵ_6^N	27	$\epsilon_1^M(\theta_i)$	42	R_1	57	G_{ss}		
13	θ_1	28	$\epsilon_2^M(\theta_i)$	43	R_2	58	G_x		
14		29	$\epsilon_6^M(\theta_i)$	44	R_3	59	G_y		


N_k/h
ϵ_j^M
R_1
R_2
R_3
R_4
$\epsilon_j^N(\theta_i) - e_j$
$\epsilon_j^M(\theta_i)$

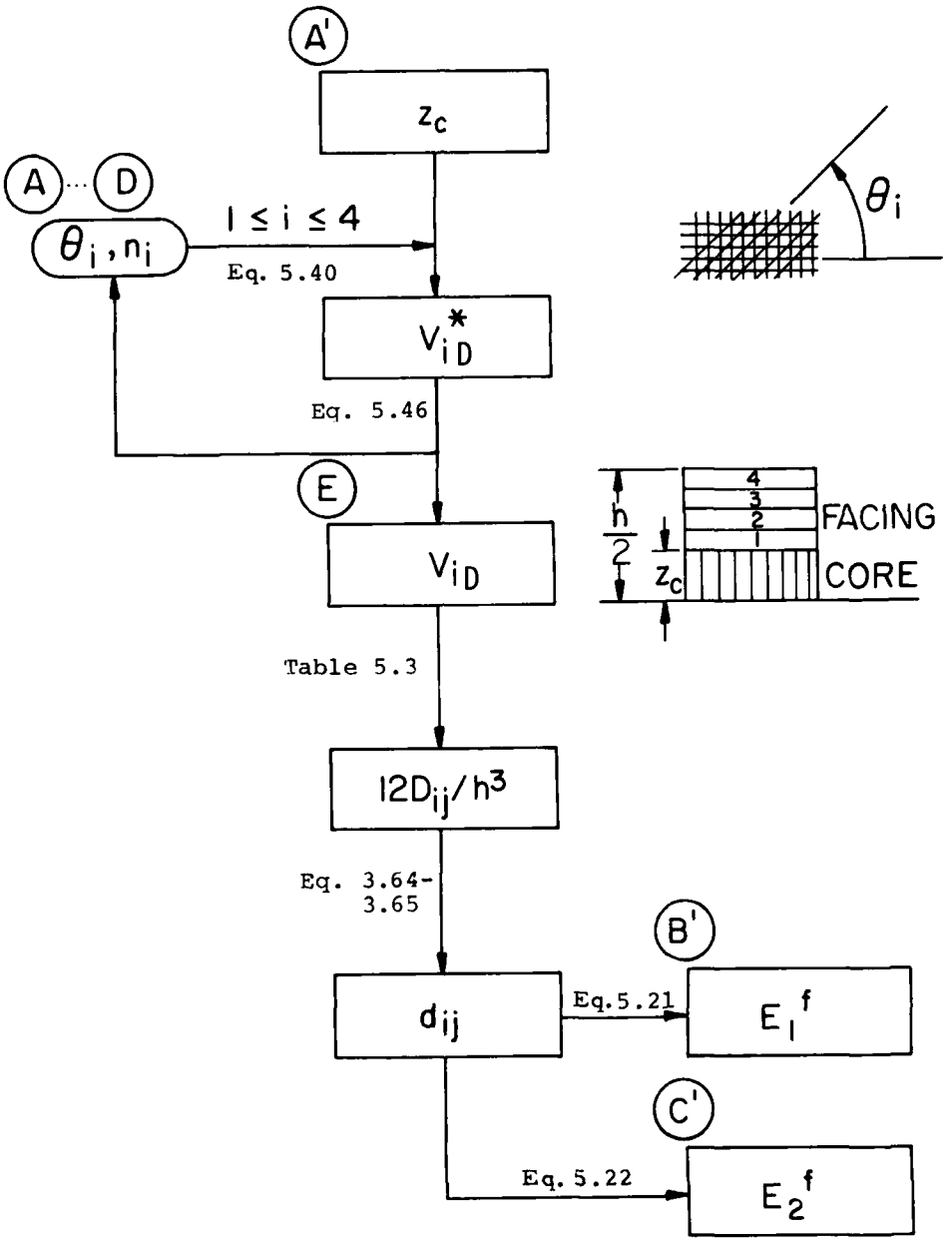
240	85	+	
241	43	RCL	
242	39	39	
243	85	+	
244	43	RCL	
245	09	09	
246	65	×	
247	43	RCL	
248	31	31	
249	38	SIN	
250	55	÷	
251	02	2	
252	95	=	
253	42	STO	
254	27	27	
255	75	-	
256	43	RCL	
257	07	07	
258	75	-	
259	43	RCL	
260	08	08	
261	95	=	
262	94	+/-	
263	42	STO	
264	28	28	
265	43	RCL	
266	09	09	
267	65	×	
268	43	RCL	
269	31	31	
270	38	COS	
271	75	-	
272	43	RCL	
273	40	40	
274	55	÷	
275	01	1	
276	65	×	
277	43	RCL	
278	31	31	
279	38	SIN	
280	95	=	
281	42	STO	
282	29	29	
283	43	RCL	
284	85	+	
285	02	2	
286	65	×	
287	43	RCL	
288	56	56	
289	65	×	
290	43	RCL	
291	27	27	
292	33	X²	
293	85	+	
294	02	2	
295	65	×	
296	43	RCL	
297	56	56	
298	65	×	
299	43	RCL	
300	27	27	
301	65	×	
302	43	RCL	
303	28	28	
304	85	+	
305	43	RCL	
306	55	55	
307	65	×	
308	43	RCL	
309	28	28	
310	33	X²	
311	95	=	
312	42	STO	
313	39	39	
314	43	RCL	
315	58	58	
316	65	×	
317	43	RCL	
318	27	27	
319	65	×	
320	85	+	
321	43	RCL	
322	59	59	
323	65	×	
324	43	RCL	
325	28	28	
326	85	+	
327	02	2	
328	65	×	
329	53	(	
330	43	RCL	
331	54	54	
332	65	×	
333	43	RCL	
334	27	27	
335	65	×	
336	43	RCL	
337	30	30	
338	85	+	
339	43	RCL	
340	56	56	
341	65	×	
342	53	(	
343	43	RCL	
344	27	27	
345	65	×	
346	43	RCL	
347	31	31	
348	85	+	
349	43	RCL	
350	28	28	
351	65	×	
352	43	RCL	
353	30	30	
354	54	)	
355	85	+	
356	43	RCL	
357	55	55	
358	65	×	
359	43	RCL	
360	28	28	
361	65	×	
362	43	RCL	
363	31	31	
364	85	+	
365	43	RCL	
366	57	57	
367	65	×	
368	43	RCL	
369	29	29	
370	65	×	
371	43	RCL	
372	32	32	
373	95	=	
374	55	÷	
375	43	RCL	
376	39	39	
377	55	÷	
378	02	2	
379	95	=	
380	42	STO	
381	40	40	
382	01	1	
383	75	-	
384	43	RCL	
385	54	54	
386	65	×	
387	43	RCL	
388	30	30	
389	33	X²	
390	75	-	
391	02	2	
392	65	×	
393	43	RCL	
394	56	56	
395	65	×	
396	43	RCL	
397	30	30	
398	65	×	
399	43	RCL	
400	31	31	
401	75	-	
402	43	RCL	
403	55	55	
404	65	×	
405	43	RCL	
406	31	31	
407	33	X²	
408	75	-	
409	43	RCL	
410	57	57	
411	65	×	
412	43	RCL	
413	32	32	
414	33	X²	
415	75	-	
416	43	RCL	
417	58	58	
418	65	×	
419	43	RCL	
420	30	30	
421	75	-	
422	43	RCL	
423	59	59	
424	65	×	
425	43	RCL	
426	31	31	
427	95	=	
428	55	÷	
429	43	RCL	
430	39	39	
431	85	+	
432	43	RCL	
433	40	40	
434	33	X²	
435	95	=	
436	34	√x	
437	42	STO	
438	39	39	
439	75	-	
440	43	RCL	
441	40	40	
442	95	=	
443	42	STO	
444	40	40	
445	75	-	
446	02	2	
447	55	÷	
448	43	RCL	
449	39	39	
450	95	=	
451	94	+/-	
452	92	RTN	
453	00	0	
454	00	0	
455	00	0	
456	00	0	
457	00	0	
458	00	0	
459	00	0	
460	00	0	
461	00	0	
462	00	0	
463	00	0	
464	00	0	
465	00	0	
466	00	0	
467	00	0	
468	00	0	
469	00	0	
470	00	0	
471	00	0	
472	00	0	
473	00	0	
474	00	0	
475	00	0	
476	00	0	
477	00	0	
478	00	0	
479	00	0	

R_i

N_K	0. 00	0. 00	00	0. 00	0. 00	00
	1. 00	1. 00	01	1. 00	1. 00	01
	0. 00	0. 00	02	0. 00	0. 00	02
	0. 00	0. 00	03	0. 00	0. 00	03
	7.3107032 06	0. 00	04	7.3107032 06	0. 00	04
	7.3107032 06	0. 00	05	7.3107032 06	0. 00	05
	0. 00	0. 00	06	0. 00	0. 00	06
	10.417611-12	10.417611-12	07	39.919255-12	39.919255-12	07
	-314.10757-15	-314.10757-15	08	-29.815752-12	-29.815752-12	08
	0. 00	0. 00	09	0. 00	0. 00	09
	75.363712-06	0. 00	10	75.363712-06	0. 00	10
	75.363712-06	0. 00	11	75.363712-06	0. 00	11
	0. 00	0. 00	12	0. 00	0. 00	12
	0. 00	0. 00	13	45. 00	45. 00	13
θ_i	1. 00	1. 00	14	1. 00	1. 00	14
	90. 00	90. 00	15	-45. 00	-45. 00	15
n_i	1. 00	1. 00	16	1. 00	1. 00	16
	68. 06	68. 06	17	68. 06	68. 06	17
	181. 09	181. 09	18	181. 09	181. 09	18
	10.3 09	10.3 09	19	10.3 09	10.3 09	19
	280. -03	280. -03	20	280. -03	280. -03	20
	180. 00	180. 00	21	-90. 00	-90. 00	21
	10. -09	10. -09	22	10. -09	10. -09	22
	12.5-06	12.5-06	23	12.5-06	12.5-06	23
	0. 00	0. 00	24	0. 00	0. 00	24
	600. -03	600. -03	25	600. -03	600. -03	25
	500. -06	500. -06	26	500. -06	500. -06	26
	-314.10757-15	-314.10757-15	27	5.0517515-12	5.0517515-12	27
	10.417611-12	10.417611-12	28	5.0517515-12	5.0517515-12	28
	0. 00	0. 00	29	69.735007-12	69.735007-12	29
	75.363712-06	0. 00	30	75.363712-06	0. 00	30
	-1.0511363-03	0. 00	31	-1.0511363-03	0. 00	31
	0. 00	0. 00	32	0. 00	0. 00	32
	10.417611-12	10.417611-12	33	39.919255-12	39.919255-12	33
	10.417611-12	10.417611-12	34	39.919255-12	39.919255-12	34
	-314.10757-15	-314.10757-15	35	-29.815752-12	-29.815752-12	35
	139.47001-12	139.47001-12	36	21.463436-12	21.463436-12	36
	0. 00	0. 00	37	0. 00	0. 00	37
	0. 00	0. 00	38	0. 00	0. 00	38
	1.3193015 09	1.3211072 09	39	149.56132 06	136.08024 06	39
	473.81212 06	373.39552 06	40	137.38862 06	123.2282 06	40
	125. -06	125. -06	41	125. -06	125. -06	41
R_i	739.83225 06	681.88201 06	42	137.38862 06	123.2282 06	42
	473.81212 06	373.39552 06	43	137.38862 06	123.2282 06	43
	85.73249 09	85.73249 09	44	85.73249 09	85.73249 09	44
	19.710431 09	19.710431 09	45	19.710431 09	19.710431 09	45
	2. 00	2. 00	46	2. 00	2. 00	46
R_i'	1.2360994 09	1.1077053 09	47	161.73402 06	148.93229 06	47
	2.1647909 09	2.2688189 09	48	161.73402 06	148.93229 06	48
	0. 00	0. 00	49	0. 00	0. 00	49
	5. -03	0. 00	50	5. -03	0. 00	50
	-3.3603243-18	-3.3603243-18	51	-3.3603243-18	-3.3603243-18	51
	-1.5-06	0. 00	52	-1.5-06	0. 00	52
	1.125-03	0. 00	53	1.125-03	0. 00	53
	12.004384 03	12.004384 03	54	12.004384 03	12.004384 03	54
	10.680652 03	10.680652 03	55	10.680652 03	10.680652 03	55
	-3.0691032 03	-3.0691032 03	56	-3.0691032 03	-3.0691032 03	56
	11.117842 03	11.117842 03	57	11.117842 03	11.117842 03	57
	60.646995 00	60.646995 00	58	60.646995 00	60.646995 00	58
	216.59641 00	216.59641 00	59	216.59641 00	216.59641 00	59
	$\Delta T = -150°C$	0		-150°C	0	
	$\epsilon = .005$	0		.005	0	

TAPE #6

FLEXURAL RIGIDITY OF SYMMETRIC SANDWICH PLATES



USER INSTRUCTIONS

TAPE #6: FLEXURAL RIGIDITY OF SYMMETRIC SANDWICH PLATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results from Tapes #4 for in-plane non-mechanical strains e_j^N shall be in place. Tape #6 can be used by manually inputting (θ_i, n_i^*), instead of Tape #3.	--	--	--
1	Enter core half thickness z_c and initialize z_i	z_c	A'	0.00
2	Ply angle θ_i^{**} and position z_i for computation of $V_{1D}^*, V_{2D}^*, V_{3D}^*$, and V_{4D}^* are initialized. The thickness of the laminate up to that point is displayed.	--	A	$2z_1$
		--	B	$2z_2$
		--	C	$2z_3$
		--	D	$2z_4$
3	Calculate V_{iD}, $12D_{ij}/h^3$ and d_{ij}.	--	E	1.00
4	Calculate engineering constants		B'	E_1^f
			C'	E_2^f

* Consistent with Tape #3, n_i refers to the plies of θ_i in the upper half of the laminate.

** Ply orientations are starting from the mid plane, z=0, or the upper surface of the sandwich core, $z=z_c$; this is the opposite of the usual ply orientation code which uses an ascending order from the bottom ply, $z= -h/2$.

Tape# 6 Title FLEXURAL RIGIDITY OF SYMMETRIC SANDWICH PLATES

A' z_c, z_i	B' E_1^f	C' E_2^f	D'	E'
A θ_1	B θ_2	C θ_3	D θ_4	E D^*_{ij}, d_{ij}

00		15	θ_2	30	$12D_{66}/h^3$	45	U_3
01		16	n_2, z_2	31	$12D_{16}/h^3$	46	$1-(2z_c/h)^3$
02		17	θ_3	32	$12D_{26}/h^3$	47	
03		18	n_3, z_3	33	d_{11}	48	
04		19	θ_4	34	d_{22}	49	$2\theta_i$
05		20	n_4, $z_4=\frac{h}{2}$	35	d_{12}	50	$z_i^3-z_{i-1}^3$
06		21	z_c	36	d_{66}	51	$h/2, h^3/12$
07		22	V_{1D}	37	d_{16}	52	e_x
08		23	V_{2D}	38	d_{26}	53	e_y
09		24	V_{3D}	39	$\|D\|$	54	G_{xx}
10	e_1^N	25	V_{4D}	40		55	G_{yy}
11	e_2^N	26		41	h_o	56	G_{xy}
12	e_6^N	27	$12D_{11}/h^3$	42	$\frac{1}{2}(U_1+U_4)$	57	G_{ss}
13	θ_1	28	$12D_{22}/h^3$	43	$U_5=\frac{1}{2}(U_1-U_4)$	58	G_x
14	n_1, z_1	29	$12D_{12}/h^3$	44	U_2	59	G_y

z_1

050	76	LBL
051	11	A
052	43	RCL
053	11	11
054	42	STO
055	51	51
056	65	×
057	03	3
058	75	-
059	43	RCL
060	21	21
061	45	Y^x
062	03	3
063	95	=
064	42	STO
065	50	50
066	43	RCL
067	11	11
068	71	SBR
069	33	X²

z_2

070	76	LBL
071	12	B
072	43	RCL
073	16	16
074	42	STO
075	51	51
076	45	Y^x
077	03	3
078	75	-
079	43	RCL
080	14	14
081	45	Y^x
082	03	3
083	95	=
084	42	STO
085	50	50
086	43	RCL
087	15	15
088	71	SBR
089	33	X²

z_3

090	76	LBL
091	13	C
092	43	RCL
093	13	13
094	42	STO
095	51	51
096	45	Y^x
097	03	3
098	75	-
099	43	RCL
100	16	16
101	45	Y^x
102	03	3
103	95	=
104	42	STO
105	50	50
106	43	RCL
107	11	11
108	71	SBR
109	33	X²

z_4

110	76	LBL
111	14	D
112	43	RCL
113	20	20
114	42	STO
115	51	51
116	45	Y^x
117	03	3
118	75	-
119	43	RCL
120	18	18
121	45	Y^x
122	03	3
123	95	=
124	42	STO
125	50	50
126	43	RCL
127	19	19

V_{cD}^*

128	76	LBL
129	33	X²
130	65	×
131	02	2
132	95	=
133	94	+/-
134	42	STO
135	49	49
136	39	COS
137	65	×
138	43	RCL
139	50	50
140	95	=
141	44	SUM
142	22	22
143	43	RCL
144	49	49
145	38	SIN
146	65	×
147	43	RCL
148	50	50
149	95	=
150	44	SUM
151	24	24
152	02	2
153	49	PRD
154	49	49
155	43	RCL
156	49	49
157	39	COS
158	65	×
159	43	RCL
160	50	50
161	95	=
162	44	SUM
163	23	23
164	43	RCL
165	49	49
166	38	SIN
167	65	×
168	43	RCL
169	50	50
170	95	=
171	44	SUM
172	25	25
173	43	RCL
174	51	51
175	65	×
176	02	2
177	95	=
178	91	R/S

V_{cD}

179	76	LBL
180	15	E
181	01	1
182	05	5
183	66	PAU
184	43	RCL
185	51	51
186	45	Y^x
187	03	3
188	95	=
189	35	1/x
190	49	PRD
191	23	23
192	49	PRD
193	21	21
194	49	PRD
195	24	24
196	49	PRD
197	25	25
198	65	×
199	43	RCL
200	21	21
201	45	Y^x
202	03	3
203	75	-
204	01	1
205	95	=
206	94	+/-
207	42	STO
208	46	46

$\frac{12}{t^3} D_{ij}$

209	43	RCL
210	42	42
211	85	+
212	43	RCL
213	43	43
214	95	=
215	65	×
216	43	RCL
217	46	46
218	85	+
219	43	RCL
220	22	22
221	65	×
222	43	RCL
223	44	44
224	85	+
225	43	RCL
226	23	23
227	65	×
228	43	RCL
229	45	45
230	95	=
231	42	STO
232	27	27
233	75	-
234	02	2
235	65	×
236	43	RCL
237	22	22
238	65	×
239	43	RCL

Tape #6 Flexural Rigidity

```
240  44  44
241  95  =
242  42  STO
243  28  28
244  43  RCL
245  42  42
246  75  -
247  43  RCL
248  43  43
249  95  =
250  65  ×
251  43  RCL
252  46  46
253  75  -
254  43  RCL
255  23  23
256  65  ×
257  43  RCL
258  45  45
259  95  =
260  42  STO
261  29  29
262  75  -
263  43  RCL
264  42  42
265  65  ×
266  43  RCL
267  46  46
268  85  +
269  02  2
270  65  ×
271  43  RCL
272  43  43
273  65  ×
274  43  RCL
275  46  46
276  95  =
277  42  STO
278  30  30
279  43  RCL
280  24  24
281  65  ×
282  43  RCL
283  44  44
284  55  ÷
285  02  2
286  85  +
287  43  RCL
288  25  25
289  65  ×
290  43  RCL
291  45  45
292  95  =
293  94  +/-
294  42  STO
295  31  31
296  85  +
297  02  2
298  65  ×
299  43  RCL
300  25  25
301  65  ×
302  43  RCL
303  45  45
304  95  =
305  42  STO
306  32  32
```

$|D|$

```
307  43  RCL
308  27  27
309  65  ×
310  43  RCL
311  28  28
312  65  ×
313  43  RCL
314  30  30
315  85  +
316  43  RCL
317  29  29
318  65  ×
319  43  RCL
320  31  31
321  65  ×
322  43  RCL
323  33  33
324  65  ×
325  02  2
326  75  -
327  43  RCL
328  28  28
329  65  ×
330  43  RCL
331  31  31
332  33  X²
333  75  -
334  43  RCL
335  27  27
336  65  ×
337  43  RCL
338  32  32
339  33  X²
340  75  -
341  43  RCL
342  30  30
343  65  ×
344  43  RCL
345  29  29
346  33  X²
347  95  =
348  42  STO
349  39  39
```

d_{ij}^*

```
350  43  RCL
351  28  28
352  65  ×
353  43  RCL
354  30  30
355  75  -
356  43  RCL
357  32  32
358  33  X²
359  95  =
360  42  STO
361  33  33
362  43  RCL
363  27  27
364  65  ×
365  43  RCL
366  28  28
367  75  -
368  43  RCL
369  29  29
370  33  X²
371  95  =
372  42  STO
373  36  36
374  43  RCL
375  27  27
376  65  ×
377  43  RCL
378  30  30
379  75  -
380  43  RCL
381  31  31
382  33  X²
383  95  =
384  42  STO
385  34  34
386  43  RCL
387  29  29
388  65  ×
389  43  RCL
390  32  32
391  75  -
392  43  RCL
393  28  28
394  65  ×
395  43  RCL
396  31  31
397  95  =
398  42  STO
399  37  37
```

```
400  43  RCL
401  31  31
402  65  ×
403  43  RCL
404  33  33
405  75  -
406  43  RCL
407  29  29
408  65  ×
409  43  RCL
410  30  30
411  95  =
412  42  STO
413  35  35
414  43  RCL
415  29  29
416  65  ×
417  43  RCL
418  31  31
419  75  -
420  43  RCL
421  27  27
422  65  ×
423  43  RCL
424  32  32
425  95  =
426  42  STO
427  38  38
```

d_{ij}

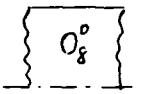
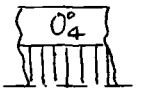
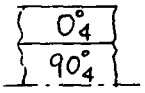
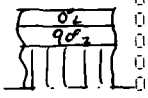
```
428  43  RCL
429  51  51
430  45  ÷R
431  03  3
432  65  ×
433  02  2
434  55  ÷
435  03  3
436  95  =
437  42  STO
438  51  51
439  65  ×
440  43  RCL
441  39  39
442  95  =
443  35  1/X
444  49  PRD
445  33  33
446  49  PRD
447  34  34
448  49  PRD
449  35  35
450  49  PRD
451  36  36
452  49  PRD
453  37  37
454  49  PRD
455  38  38
456  01  1
457  95  =
458  91  R/S
```

E_1^f

```
459  76  LBL
460  17  B'
461  43  RCL
462  33  33
463  65  ×
464  43  RCL
465  51  51
466  95  =
467  35  1/X
468  91  R/S
```

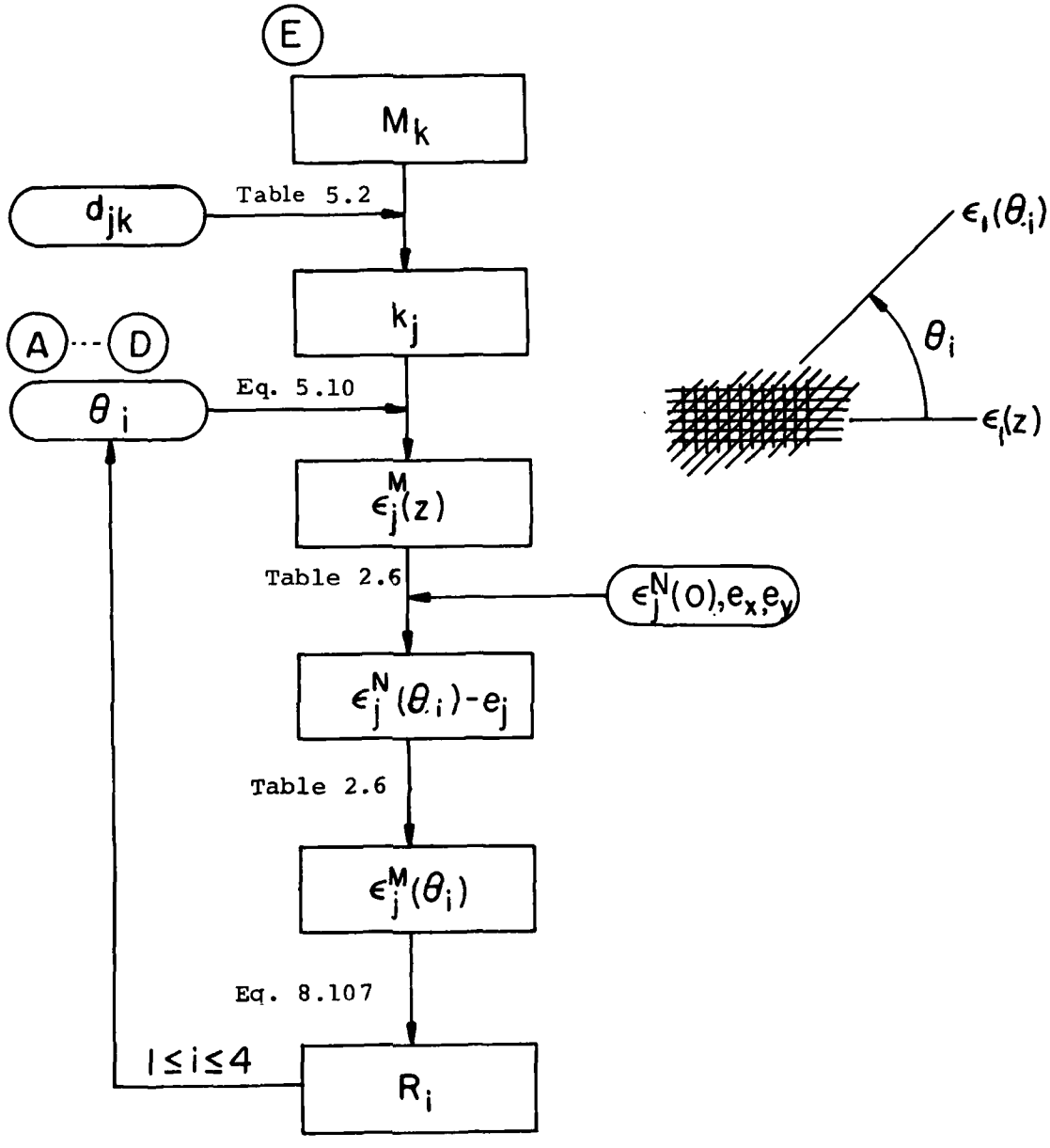
E_2^f

```
469  76  LBL
470  18  C'
471  43  RCL
472  34  34
473  65  ×
474  43  RCL
475  51  51
476  95  =
477  35  1/X
478  91  R/S
479  00  0
```

	0. 00	0. 00	0. 00	0. 00 00
	181.8 114 09	181.81114 09	181.8 14 09	181.8 114 09 01
	10.34 159 09	10.3461 59 09	10.34 159 09	10.34 159 09 02
	2.8964244 09	2.8964244 09	2.8964244 09	2.8964244 09 03
	0. 00	0. 00	0. 00	0. 00 04
	0. 00	0. 00 	0. 00 	0. 00  0. 00 05
	0. 00	0. 00	0. 00	0. 00 06
	0. 00	0. 00	0. 00	0. 00 07
	0. 00	0. 00	0. 00	0. 00 08
	0. 00	0. 00	0. 00	0. 00 09
$[0_8]_s$	0. 00	0. 00 $[0_4/core_4]_s$	0. 00 $[0_4/90_4]_s$	0. 00 $[0_2/90_2/core]_s$ 0. 00 10
	0. 00	0. 00	0. 00	0. 00 11
	0. 00	0. 00	0. 00	0. 00 12
	0. 00	0. 00	90. 00	90. 00 13
θ_1, z_1	1. -03	1. -03	500. -06	750. -06 14
	40. 06	40. 06	0. 00 θ_2, z_2	0. 00 15
	3.8447501 00	30.750001 00	1. -03	1. -03 16
	68. 06	68. 06	68. 06	68. 06 17
	2.8954135 03	22.65575 06	2.8284126 03	22.625 06 18
	10.3 09	10.3 09	10.3 09	10.3 09 19
	5.6677823 03	22.65575 06	5.6542751 03	22.625 06 20
z_c	0. 00	500. -06	0. 00	500. -06 21
	1. 00	875. -03	750. -03	281.25-03 22
	1. 00	875. -03	1. 00	875. -03 23
	0. 00	0. 00	0. 00	0. 00 24
	0. 00	0. 00	0. 00	0. 00 25
	0. 00	0. 00	0. 00	0. 00 26
	181.8 114 09	159.00475 09	160.3 902 09	108.18108 09 27
	10.34 159 09	9.0526034 09	31.774281 09	59.956555 09 28
	2.8964244 09	2.5348089 09	2.896 244 09	2.5348089 09 29
$\frac{12D_{ij}}{h^3}$	7.17 09	6.27375 09	7.17 09	6.27375 09 30
	0. 00	0. 00	0. 00	0. 00 31
	0. 00	0. 00	0. 00	0. 00 32
	8.887 720-03	9.4711418-03	9.068 286-03	13.87939-03 33
	145.63107-03	166.43551-03	47.278412-03	25.042923-03 34
	-2.320442-03	-2.651 137-03	-858.99479-06	-586.78489-06 35
d_{ij}	209.20502-03	239.09145-03	209.20502-03	239.09145-03 36
	0. 00	0. 00	0. 00	0. 00 37
	0. 00	0. 00	0. 00	0. 00 38
	13.425434 30	8.994 971 30	86.483150 30	40.653267 30 39
	0. 00	0. 00	0. 00	0. 00 40
	125. -06	125. -06	125. -06	125. -06 41
	49.487787 09	49.487787 09	49.487787 09	49.487787 09 42
	26.880431 09	26.880431 09	26.880431 09	26.880431 09 43
	85.73249 09	85.73249 09	85.73249 09	85.73249 09 44
$1-\left(\frac{z_c}{\frac{h}{2}}\right)^3$	19.710431 09	19.710431 09	19.710431 09	19.710431 09 45
	1. 00	875. -03	1. 00	875. -03 46
	0. 00	0. 00	0. 00	0. 00 47
	101.62602-18	101.62602-18	101.62602-18	101.62602-18 48
	0. 00	0. 00	0. 00	0. 00 49
$\frac{h^3}{12}$	1. -09	875. -12	875. -12	578.125-12 50
	666.66667-12	666.66667-12	666.66667-12	666.66667-12 51
	0. 00	0. 00	0. 00	0. 00 52
	0. 00	0. 00	0. 00	0. 00 53
	12.004384 03	12.004384 03	12.004384 03	12.004384 03 54
	10.680652 03	10.680652 03	10.680652 03	10.680652 03 55
	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03 56
	11.117842 03	11.117842 03	11.117842 03	11.117842 03 57
	60.646995 00	60.646995 00	60.646995 00	60.646995 00 58
	216.59641 00	216.59641 00	216.59641 00	216.59641 00 59

TAPE #7

FLEXURAL STRENGTH OF SYMMETRIC SANDWICH PLATES



USER INSTRUCTION

TAPE #7: FLEXURAL STRENGTH OF SYMMETRIC SANDWICH PLATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results from Tape#6 must be in storage	--	--	--
1	Enter Moments M_k and calculate curvature k_j.	M_1	E	M_1
		M_2	R/S	M_2
		M_6	R/S	1.00
2	Calculate ply strains and the strength ratios at the outer face of each ply.	--	A	R_1
	These strength-strain ratios are based onmechanical strains, not the total strains.	--	B	R_2
		--	C	R_3
		--	D	R_4

Tape# 7 Title FLEXURAL STRENGTH OF SYMMETRIC SANDWICH PLATES

A'	B'	C'	D'	E'
A R_1	B R_2	C R_3	D R_4	E M_k

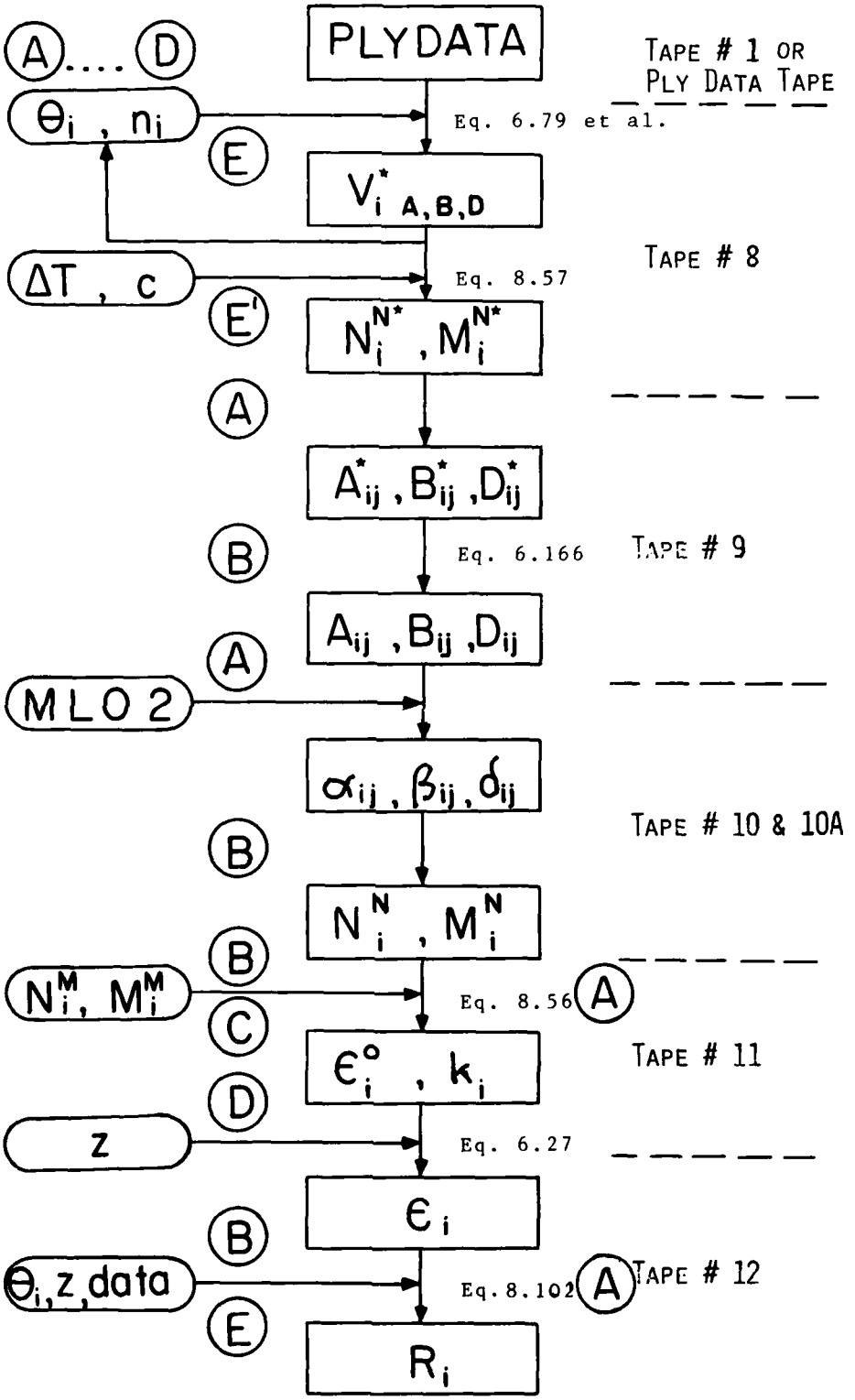
00	15 θ_2	30 $e_1^N(\theta_i)-e_x$	45 R_4
01 M_1	16 z_2	31 $e_2^N(\theta_i)-e_y$	46 $1-(2z_c/h)^3$
02 M_2	17 θ_3	32 $e_6^N(\theta_i)$	47 R'_1
03 M_6	18 z_3	33 d_{11}	48 R'_2
04 k_1	19 θ_4	34 d_{22}	49 R'_3
05 k_2	20 z_4	35 d_{12}	50 θ_i, R'_4
06 k_6	21 z_c	36 d_{66}	51 $h/2, h^3/12$
07 $e_1^{M(z)}$	22	37 d_{16}	52 e_x
08 $e_2^{M(z)}$	23	38 d_{26}	53 e_y
09 $e_6^{M(z)}$	24	39 $\ldots R'_i$	54 G_{xx}
10 e_1^N	25	40 $\ldots R_i$	55 G_{yy}
11 e_2^N	26 M_6	41 h_o	56 G_{xy}
12 e_6^N	27 $e_1^{M(\theta_i)}$	42 R_1	57 G_{ss}
13 θ_1	28 $e_2^{M(\theta_i)}$	43 R_2	58 G_x
14 z_1	29 $e_6^{M(\theta_i)}$	44 R_3	59 G_y

M_k	000	76	LBL
	001	15	E
	002	42	STO
	003	01	01
	004	91	R/S
	005	42	STO
	006	02	02
	007	91	R/S
	008	42	STO
	009	03	03
	010	65	×
k_j	011	43	RCL
	012	37	37
	013	85	+
	014	43	RCL
	015	01	01
	016	65	×
	017	43	RCL
	018	33	33
	019	85	+
	020	43	RCL
	021	02	02
	022	65	×
	023	43	RCL
	024	35	35
	025	95	=
	026	42	STO
	027	04	04
	028	43	RCL
	029	01	01
	030	65	×
	031	43	RCL
	032	35	35
	033	85	+
	034	43	RCL
	035	02	02
	036	65	×
	037	43	RCL
	038	34	34
	039	85	+
	040	43	RCL
	041	03	03
	042	65	×
	043	43	RCL
	044	38	38
	045	95	=
	046	42	STO
	047	05	05
	048	43	RCL
	049	01	01
	050	65	×
	051	43	RCL
	052	37	37
	053	85	+
	054	43	RCL
	055	02	02
	056	65	×
	057	43	RCL
	058	38	38
	059	85	+
	060	43	RCL
	061	03	03
	062	65	×
	063	43	RCL
	064	36	36
	065	95	=
	066	42	STO
	067	06	06
	068	01	1
	069	95	=
	070	91	R/S
R_1	071	76	LBL
	072	11	A
	073	43	RCL
	074	13	13
	075	42	STO
	076	50	50
	077	43	RCL
	078	14	14
	079	71	SBR
	080	35	1/X
	081	42	STO
	082	47	47
	083	43	RCL
	084	40	40
	085	42	STO
	086	42	42
	087	91	R/S
R_2	088	76	LBL
	089	12	B
	090	43	RCL
	091	15	15
	092	42	STO
	093	50	50
	094	43	RCL
	095	16	16
	096	71	SBR
	097	35	1/X
	098	42	STO
	099	48	48
	100	43	RCL
	101	40	40
	102	42	STO
	103	43	43
	104	91	R/S
R_3	105	76	LBL
	106	13	C
	107	43	RCL
	108	17	17
	109	42	STO
	110	50	50
	111	43	RCL
	112	18	18
	113	71	SBR
	114	35	1/X
	115	42	STO
	116	49	49
	117	43	RCL
	118	40	40
	119	42	STO
	120	44	44
	121	91	R/S
R_4	122	76	LBL
	123	14	D
	124	43	RCL
	125	19	19
	126	42	STO
	127	50	50
	128	43	RCL
	129	20	20
	130	71	SBR
	131	35	1/X
	132	42	STO
	133	50	50
	134	43	RCL
	135	40	40
	136	42	STO
	137	45	45
	138	91	R/S
$\epsilon_j^M(z_i)$	139	76	LBL
	140	35	1/X
	141	42	STO
	142	40	40
	143	65	×
	144	43	RCL
	145	04	04
	146	95	=
	147	42	STO
	148	07	07
	149	01	1
	150	09	9
	151	66	PAU
	152	43	RCL
	153	40	40
	154	65	×
	155	43	RCL
	156	05	05
	157	95	=
	158	42	STO
	159	08	08
	160	43	RCL
	161	40	40
	162	65	×
	163	43	RCL
	164	06	06
	165	95	=
	166	42	STO
	167	09	09
$\epsilon_j^N(\theta_i)$	168	02	2
	169	49	PRD
	170	50	50
$-e_j$	171	43	RCL
	172	10	10
	173	85	+
	174	43	RCL
	175	11	11
	176	95	=
	177	55	-
	178	02	2
	179	95	=
	180	42	STO
	181	39	39
	182	75	-
	183	43	RCL
	184	11	11
	185	95	=
	186	42	STO
	187	40	40
	188	65	×
	189	43	RCL
	190	50	50
	191	39	COS
	192	85	+
	193	43	RCL
	194	39	39
	195	85	+
	196	43	RCL
	197	12	12
	198	65	×
	199	43	RCL
	200	50	50
	201	38	SIN
	202	55	-
	203	02	2
	204	75	-
	205	43	RCL
	206	52	52
	207	95	=
	208	42	STO
	209	30	30
	210	75	-
	211	02	2
	212	65	×
	213	43	RCL
	214	39	39
	215	85	+
	216	43	RCL
	217	52	52
	218	85	+
	219	43	RCL
	220	53	53
	221	95	=
	222	94	+/-
	223	42	STO
	224	31	31
	225	43	RCL
	226	12	12
	227	65	×
	228	43	RCL
	229	50	50
	230	39	COS
	231	75	-
	232	43	RCL
	233	40	40
	234	65	×
	235	02	2
	236	65	×
	237	43	RCL
	238	50	50
	239	38	SIN

240	95	=	
241	42	STO	
242	32	32	
243	43	RCL	$\epsilon_j^M(\theta_i)$
244	07	07	
245	85	+	
246	43	RCL	
247	08	08	
248	95	=	
249	55	÷	
250	02	2	
251	95	=	
252	42	STO	
253	39	39	
254	75	-	
255	43	RCL	
256	08	08	
257	95	=	
258	42	STO	
259	40	40	
260	65	×	
261	43	RCL	
262	50	50	
263	39	COS	
264	85	+	
265	43	RCL	
266	39	39	
267	85	+	
268	43	RCL	
269	09	09	
270	65	×	
271	43	RCL	
272	50	50	
273	38	SIN	
274	55	÷	
275	02	2	
276	95	=	
277	42	STO	
278	27	27	
279	75	-	
280	43	RCL	
281	07	07	
282	75	-	
283	43	RCL	
284	08	08	
285	95	=	
286	94	+/-	
287	42	STO	
288	28	28	
289	43	RCL	
290	09	09	
291	65	×	
292	43	RCL	
293	50	50	
294	39	COS	
295	75	-	
296	43	RCL	
297	40	40	
298	65	×	
299	02	2	
300	65	×	
301	43	RCL	
302	50	50	
303	38	SIN	
304	95	=	
305	42	STO	
306	29	29	
307	33	X^2	R_i
308	65	×	
309	43	RCL	
310	57	57	
311	85	+	
312	43	RCL	
313	54	54	
314	65	×	
315	43	RCL	
316	27	27	
317	33	X^2	
318	85	+	
319	02	2	
320	65	×	
321	43	RCL	
322	56	56	
323	65	×	
324	43	RCL	
325	27	27	
326	65	×	
327	43	RCL	
328	28	28	
329	85	+	
330	43	RCL	
331	55	55	
332	65	×	
333	43	RCL	
334	28	28	
335	33	X^2	
336	95	=	
337	42	STO	
338	39	39	
339	43	RCL	
340	58	58	
341	65	×	
342	43	RCL	
343	27	27	
344	85	+	
345	43	RCL	
346	59	59	
347	65	×	
348	43	RCL	
349	28	28	
350	85	+	
351	02	2	
352	65	×	
353	53	(	
354	43	RCL	
355	54	54	
356	65	×	
357	43	RCL	
358	27	27	
359	65	×	
360	43	RCL	
361	30	30	
362	85	+	
363	43	RCL	
364	56	56	
365	65	×	
366	53	(	
367	43	RCL	
368	27	27	
369	65	×	
370	43	RCL	
371	31	31	
372	85	+	
373	43	RCL	
374	28	28	
375	65	×	
376	43	RCL	
377	30	30	
378	54	)	
379	85	+	
380	43	RCL	
381	55	55	
382	65	×	
383	43	RCL	
384	28	28	
385	65	×	
386	43	RCL	
387	31	31	
388	85	+	
389	43	RCL	
390	57	57	
391	65	×	
392	43	RCL	
393	29	29	
394	65	×	
395	43	RCL	
396	32	32	
397	95	=	
398	55	÷	
399	43	RCL	
400	39	39	
401	55	÷	
402	02	2	
403	95	=	
404	42	STO	
405	40	40	
406	01	1	
407	75	-	
408	43	RCL	
409	54	54	
410	65	×	
411	43	RCL	
412	30	30	
413	33	X^2	
414	75	-	
415	02	2	
416	65	×	
417	43	RCL	
418	56	56	
419	65	×	
420	43	RCL	
421	30	30	
422	65	×	
423	43	RCL	
424	31	31	
425	75	-	
426	43	RCL	
427	55	55	
428	65	×	
429	43	RCL	
430	31	31	
431	33	X^2	
432	75	-	
433	43	RCL	
434	57	57	
435	65	×	
436	43	RCL	
437	32	32	
438	33	X^2	
439	75	-	
440	43	RCL	
441	58	58	
442	65	×	
443	43	RCL	
444	30	30	
445	75	-	
446	43	RCL	
447	59	59	
448	65	×	
449	43	RCL	
450	31	31	
451	95	=	
452	55	÷	
453	43	RCL	
454	39	39	
455	85	+	
456	43	RCL	
457	40	40	
458	33	X^2	
459	95	=	
460	34	$\sqrt{x}$	
461	42	STO	
462	39	39	
463	75	-	
464	43	RCL	
465	40	40	
466	95	=	
467	42	STO	
468	40	40	
469	75	-	
470	02	2	
471	65	×	
472	43	RCL	
473	39	39	
474	95	=	
475	94	+/-	
476	92	RTN	
477	00	0	
478	00	0	
479	00	0	

	0. 00	0. 00	0. 00	0. 00	00
M_k	1. 00	1. 00	1. 00	1. 00	01
	0. 00	0. 00	0. 00	0. 00	02
	0. 00	0. 00	0. 00	0. 00	03
	8.2872928-03	9.4711918-03	9.3683286-03	10.87939-03	04
	-2.320442-03	-2.6519037-03	-853.99478-06	-586.78489-06	05
	0. 00	0. 00	0. 00	0. 00	06
	8.2872928-06	9.4711918-06	9.3683286-06	10.87939-06	07
	-2.320442-06	-2.6519037-06	-853.99478-09	-586.78489-09	08
	0. 00	0. 00	0. 00	0. 00	09
	0. 00	0. 00	0. 00	0. 00	10
	0. 00	0. 00	0. 00	0. 00	11
	0. 00	0. 00	0. 00	0. 00	12
	0. 00	0. 00	90. 00	90. 00	13
	1. -03	1. -03	500. -06	750. -06	14
	40. 06	40. 06	0. 00	0. 00	15
	3.8447501 00	30.750001 03	1. -03	1. -03	16
	68. 06	68. 06	68. 06	68. 06	17
	2.8354135 03	22.65575 06	22.625 06	22.625 06	18
	10.3 09	10.3 09	10.3 09	10.3 09	19
	5.6677823 03	22.65575 06	22.625 06	22.625 06	20
	0. 00	500. -06	0. 00	500. -06	21
	1. 00	875. -03	750. -03	281.25-03	22
	1. 00	875. -03	1. 00	875. -03	23
	0. 00	0. 00	0. 00	0. 00	24
	0. 00	0. 00	0. 00	0. 00	25
	0. 00	0. 00	0. 00	0. 00	26
	8.2872928-06	9.4711918-06	9.3683286-06	10.87939-06	27
	-2.320442-06	-2.6519037-06	-853.99478-09	-586.78489-09	28
	0. 00	0. 00	0. 00	0. 00	29
	0. 00	0. 00	0. 00	0. 00	30
	0. 00	0. 00	0. 00	0. 00	31
	0. 00	0. 00	0. 00	0. 00	32
	8.2872928-03	9.4711918-03	9.3683286-03	10.87939-03	33
	145.63107-03	166.40551-03	47.278412-03	25.042923-03	34
	-2.320442-03	-2.6519037-03	-853.99478-06	-586.78489-06	35
	209.20502-03	239.09145-03	209.20502-03	239.09145-03	36
	0. 00	0. 00	0. 00	0. 00	37
	0. 00	0. 00	0. 00	0. 00	38
	1. 03	875. 00	964.5143 00	667.40582 00	39
	1. 03	875. 00	791.97978 00	516.39171 00	40
	125. -06	125. -06	125. -06	125. -06	41
R	1. 03	875. 00	835.60432 00	874.19028 00	42
	26.880431 09	26.880431 09	791.97978 00	516.39171 00	43
	85.73249 09	85.73249 09	85.73249 09	85.73249 09	44
	19.710431 09	19.710431 09	19.710431 09	19.710431 09	45
	1. 00	875. -03	1. 00	875. -03	46
R'	1. 03	875. 00	4.8092482 03	2.2499333 03	47
	101.62602-18	101.62602-18	1.1370488 03	818.41992 00	48
	0. 00	0. 00	0. 00	0. 00	49
	0. 00	0. 00	0. 00	0. 00	50
	666.66667-12	666.66667-12	666.66667-12	666.66667-12	51
	0. 00	0. 00	0. 00	0. 00	52
	0. 00	0. 00	0. 00	0. 00	53
	12.004384 03	12.004384 03	12.004384 03	12.004384 03	54
	10.680652 03	10.680652 03	10.680652 03	10.680652 03	55
	-3.0691032 03	-3.0691032 03	-3.0691032 03	-3.0691032 03	56
	11.117842 03	11.117842 03	11.117842 03	11.117842 03	57
	60.646995 00	60.646995 00	60.646995 00	60.646995 00	58
	216.59641 00	216.59641 00	216.59641 00	216.59641 00	59

TAPE # 8 - 12 GENERAL LAMINATES



TAPE #8: THE V'S AND NONMECHANICAL FORCES OF GENERAL LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Ply data must be in storage.			
1	Enter total number plies.	n	A	0
2	Enter ply angle θ_i, and number of plies at that angle n_i.	θ_1	R/S	θ_1
		n_1	R/S	V_{4D_1}
		θ_2	B	$(-\frac{n}{2}+n_1)$
		n_2	R/S	V_{4D_2}
		θ_3	C	$(-\frac{n}{2}+n_1+n_2)$
		n_3	R/S	V_{4D_3}
		θ_4	D	$(-\frac{n}{2}+n_1+n_2+n_3)$
		n_4	R/S	V_{4D_4}
		θ_5 . . .	B** . . .	$(-\frac{n}{2}+n_1+\ldots)$ . . .
3	Calculate V_{ij}^*		E	$4/n^3$
4	Calculate N_i^{N*}, M_i^{N*}	ΔT	E'	ΔT
		c	R/S	M_6^{N*}

**Additional plies can be entered through B, C, or D key. Key A cannot be used for this purpose because it initializes the summation process.

Tape# 8 Title THE V'S AND NONMECHANICAL FORCES OF GENERAL LAMINATES

A'	B'	C'	D'	E'
				ΔT, c
A n, θ_1, n_1	B θ_2, n_2	C θ_3, n_3	D θ_4, n_4	E V_i^*
00 θ_1	15 $1/n^2$	30 Q_{ss}	45 U_3	
01 n_1	16 $4/n^3$	31 V_{1A}^*	46 $-n/2$	
02 θ_2	17 h	32 V_{2A}^*	47 V_{3D}^*	
03 n_2	18 E_x	33 V_{3A}^*	48 V_{4D}^*	
04 θ_3	19 E_y	34 V_{4A}^*	49 $2\theta_i$	
05 n_3	20 ν_x	35 V_{1B}^*	50 $4\theta_i$	
06 θ_4	21 E_s	36 V_{2B}^*	51 N_1^{N*}	
07 n_4, ΔT	22 α_x	37 V_{3B}^*	52 N_2^{N*}	
08 c	23 α_y	38 V_{4B}^*	53 N_6^{N*}	
09 $1/n$	24 β_x	39 V_{1D}^*	54 M_1^{N*}	
10 n_{i+1}, p^N	25 β_y	40 V_{2D}^*	55 M_2^{N*}	
11 n_i, q^N	26 n	41 h_o	56 M_6^{N*}	
12 $n_{i+1} - n_i$	27 Q_{xx}	42 $\frac{1}{2}(U_1+U_4)$	57 e_x	
13 $n_{i+1}^2 - n_i^2$	28 Q_{yy}	43 $U_5=\frac{1}{2}(U_1-U_4)$	58 e_y	
14 $n_{i+1}^3 - n_i^3$	29 Q_{xy}	44 U_2	59 G_y	

Tape # 8 V's and Nonmechanical Forces

n	000	76	LBL	
	001	11	A	
	002	57	ENG	
	003	42	STO	
	004	26	26	
	005	99	PRT	
	006	55	÷	
	007	02	2	
	008	95	=	
	009	94	+/-	
	010	42	STO	
	011	46	46	
	012	42	STO	
	013	11	11	
	014	00	0	
	015	49	PRD	
	016	47	47	
	017	49	PRD	
	018	48	48	
	019	49	PRD	
	020	31	31	
	021	49	PRD	
	022	32	32	
	023	49	PRD	
	024	33	33	
	025	49	PRD	
	026	34	34	
	027	49	PRD	
	028	35	35	
	029	49	PRD	
	030	36	36	
	031	49	PRD	
	032	37	37	
	033	49	PRD	
	034	38	38	
	035	49	PRD	
	036	39	39	
	037	49	PRD	
	038	40	40	
	039	91	R/S	
	040	99	PRT	
	041	42	STO	
θ_1, n_1	042	00	00	
	043	91	R/S	
	044	99	PRT	
	045	42	STO	
	046	01	01	
	047	85	+	
	048	43	RCL	
	049	46	46	
	050	95	=	
	051	42	STO	
	052	10	10	
	053	43	RCL	
	054	41	41	
	055	42	STO	
	056	09	09	
	057	33	x^2	
	058	42	STO	
	059	15	15	
	060	65	×	
	061	43	RCL	
	062	41	41	
	063	95	=	
	064	42	STO	
	065	16	16	
	066	43	RCL	
	067	41	41	
	068	65	×	
	069	43	RCL	
	070	26	26	
	071	95	=	
	072	42	STO	
	073	17	17	
	074	35	1/x	
	075	49	PRD	
	076	09	09	
	077	33	x^2	
	078	49	PRD	
	079	15	15	
	080	43	RCL	
	081	17	17	
	082	45	Y^x	
	083	03	3	
	084	95	=	
	085	35	1/x	
	086	65	×	
	087	04	4	
	088	95	=	
	089	49	PRD	
	090	16	16	
	091	71	SBR	
	092	89	π	
	093	43	RCL	
	094	00	00	
	095	71	SBR	
	096	33	x^2	
	097	91	R/S	
θ_2, n_2	098	76	LBL	
	099	12	B	
	100	42	STO	
	101	02	02	
	102	99	PRT	
	103	43	RCL	
	104	10	10	
	105	42	STO	
	106	11	11	
	107	91	R/S	
	108	42	STO	
	109	03	03	
	110	99	PRT	
	111	44	SUM	
	112	10	10	
	113	71	SBR	
	114	89	π	
	115	43	RCL	
	116	02	02	
	117	71	SBR	
	118	33	x^2	
	119	91	R/S	
θ_3, n_3	120	76	LBL	
	121	13	C	
	122	42	STO	
	123	04	04	
	124	99	PRT	
	125	43	RCL	
	126	10	10	
	127	42	STO	
	128	11	11	
	129	91	R/S	
	130	42	STO	
	131	05	05	
	132	99	PRT	
	133	44	SUM	
	134	10	10	
	135	71	SBR	
	136	89	π	
	137	43	RCL	
	138	04	04	
	139	71	SBR	
	140	33	x^2	
	141	91	R/S	
θ_4, n_4	142	76	LBL	
	143	14	D	
	144	42	STO	
	145	06	06	
	146	99	PRT	
	147	43	RCL	
	148	10	10	
	149	42	STO	
	150	11	11	
	151	91	R/S	
	152	42	STO	
	153	07	07	
	154	99	PRT	
	155	44	SUM	
	156	10	10	
	157	71	SBR	
	158	89	π	
	159	43	RCL	
	160	06	06	
	161	71	SBR	
	162	33	x^2	
Δ	163	76	LBL	
	164	89	π	
	165	43	RCL	
	166	10	10	
	167	75	-	
	168	43	RCL	
	169	11	11	
	170	95	=	
	171	42	STO	
	172	12	12	
	173	43	RCL	
	174	10	10	
	175	33	x^2	
	176	75	-	
	177	43	RCL	
	178	11	11	
	179	33	x^2	
	180	95	=	
	181	42	STO	
	182	13	13	
	183	43	RCL	
	184	10	10	
	185	33	x^2	
	186	65	×	
	187	43	RCL	
	188	10	10	
	189	75	-	
	190	53	(	
	191	43	RCL	
	192	11	11	
	193	33	x^2	
	194	65	×	
	195	43	RCL	
	196	11	11	
	197	54	)	
	198	95	=	
	199	42	STO	
	200	14	14	
	201	92	RTN	
	202	76	LBL	
V_i	203	33	x^2	
	204	65	×	
	205	02	2	
	206	95	=	
	207	42	STO	
	208	49	49	
	209	65	×	
	210	02	2	
	211	95	=	
	212	42	STO	
	213	50	50	
	214	43	RCL	
	215	49	49	
	216	39	COS	
	217	65	×	
	218	43	RCL	
	219	12	12	
	220	95	=	
	221	44	SUM	
	222	31	31	
	223	43	RCL	
	224	50	50	
	225	39	COS	
	226	65	×	
	227	43	RCL	
	228	12	12	
	229	95	=	
	230	44	SUM	
	231	32	32	
	232	43	RCL	
	233	49	49	
	234	38	SIN	
	235	65	×	
	236	43	RCL	
	237	12	12	
	238	95	=	
	239	44	SUM	

```
239  44 SUM
240  33  33
241  43 RCL
242  50  50
243  38 SIN
244  65  ×
245  43 RCL
246  12  12
247  95  =
248  44 SUM
249  34  34
250  43 RCL
251  49  49
252  39 COS
253  65  ×
254  43 RCL
255  13  13
256  95  =
257  44 SUM
258  35  35
259  43 RCL
260  50  50
261  39 COS
262  65  ×
263  43 RCL
264  13  13
265  95  =
266  44 SUM
267  36  36
268  43 RCL
269  49  49
270  38 SIN
271  65  ×
272  43 RCL
273  13  13
274  95  =
275  44 SUM
276  37  37
277  43 RCL
278  50  50
279  38 SIN
280  65  ×
281  43 RCL
282  13  13
283  95  =
284  44 SUM
285  38  38
286  43 RCL
287  49  49
288  39 COS
289  65  ×
290  43 RCL
291  14  14
292  95  =
293  44 SUM
294  39  39
295  43 RCL
296  50  50
297  39 COS
298  65  ×
299  43 RCL
300  14  14
301  95  =
302  44 SUM
303  40  40
304  43 RCL
305  49  49
306  38 SIN
307  65  ×
308  43 RCL
309  14  14
310  95  =
311  44 SUM
312  47  47
313  43 RCL
314  50  50
315  38 SIN
316  65  ×
317  43 RCL
318  14  14
319  95  =
```

$V^{*}_{i,A,B,D}$

```
320  44 SUM
321  48  48
322  92 RTN
323  76 LBL
324  15  E
325  43 RCL
326  09  09
327  49 PRD
328  31  31
329  49 PRD
330  32  32
331  49 PRD
332  33  33
333  49 PRD
334  34  34
335  43 RCL
336  15  15
337  49 PRD
338  35  35
339  49 PRD
340  36  36
341  49 PRD
342  37  37
343  49 PRD
344  38  38
345  43 RCL
346  16  16
347  49 PRD
348  39  39
349  49 PRD
350  40  40
351  49 PRD
352  47  47
353  49 PRD
354  48  48
355  91 R/S
```

N^{N*}_{i}

M^{N*}_{i}

```
356  76 LBL
357  10 E'
358  42 STO
359  07  07
360  99 PRT
361  91 R/S
362  42 STO
363  08  08
364  99 PRT
365  65  ×
366  43 RCL
367  24  24
368  85  +
369  43 RCL
370  07  07
371  65  ×
372  43 RCL
373  22  22
374  95  =
375  42 STO
376  57  57
377  43 RCL
378  07  07
379  65  ×
380  43 RCL
381  23  23
382  85  +
383  43 RCL
384  08  08
385  65  ×
386  43 RCL
387  25  25
388  95  =
389  42 STO
390  58  58
391  65  ×
392  43 RCL
393  29  29
394  85  +
395  43 RCL
396  57  57
397  65  ×
398  43 RCL
399  27  27
```

```
400  95  =
401  42 STO
402  10  10
403  43 RCL
404  54  54
405  65  ×
406  43 RCL
407  33  33
408  85  +
409  43 RCL
410  58  58
411  65  ×
412  43 RCL
413  28  28
414  95  =
415  42 STO
416  11  11
417  85  +
418  43 RCL
419  10  10
420  95  =
421  55  ÷
422  02  2
423  95  =
424  42 STO
425  10  10
426  75  -
427  43 RCL
428  11  11
429  95  =
430  42 STO
431  11  11
432  65  ×
433  43 RCL
434  31  31
435  85  +
436  43 RCL
437  10  10
438  95  =
439  42 STO
440  51  51
441  75  -
442  02  2
443  65  ×
444  43 RCL
445  31  31
446  65  ×
447  43 RCL
448  11  11
449  95  =
450  42 STO
451  52  52
452  43 RCL
453  33  33
454  65  ×
455  43 RCL
456  11  11
457  95  =
458  42 STO
459  53  53
460  43 RCL
461  11  11
462  65  ×
463  43 RCL
464  35  35
465  95  =
466  42 STO
467  54  54
468  94 +/-
469  42 STO
470  55  55
471  43 RCL
472  11  11
473  65  ×
474  43 RCL
475  37  37
476  95  =
477  42 STO
478  56  56
479  91 R/S
```

$[+45_8 / -45_8]_T$

```
        16.  00
        45.  00
         8.  00
       -45.  00
         8.  00
      -150.  00
         5. -03
```

```
        45.  00    00
         8.  00    01
       -45.  00    02
         8.  00    03
         0.  00    04
         0.  00    05
       -45.  00    06
ΔT   -150.  00    07
c       5. -03    08
      62.5-03     09
 7.3107032  06    10
-4.3243799  06    11
         8.  00    12
        64.  00    13
       512.  00    14
 3.90625-03        15
976.5625-06        16
         2. -03    17
       181.  09    18
      10.3  09     19
       280. -03    20
      7.17  09     21
        10. -09    22
      12.5-06      23
         0.  00    24
       600. -03    25
        16.  00    26
181.81114  09      27
10.346159  09      28
2.8969244  09      29
      7.17  09     30
         0.  00    31
        -1.  00    32
         0.  00    33
         0.  00    34
         0.  00    35
         0.  00    36
      -500. -03    37
         0.  00    38
         0.  00    39
        -1.  00    40
       125. -06    41
49.487787  09      42
26.880431  09      43
 85.73249  09      44
19.710431  09      45
        -8.  00    46
         0.  00    47
         0.  00    48
       -90.  00    49
      -180.  00    50
 7.3107032  06     51
 7.3107032  06     52
         0.  00    53
         0.  00    54
         0.  00    55
 2.16219  06       56
    -1.5-06         57
   1.125-03         58
216.59641  00       59
```

$[0_8 / 90_8]_T$

```
        16.  00
         0.  00
         8.  00
        90.  00
         8.  00
      -150.  00
         5. -03
```

```
         0.        00
         8.        01
        90.        02
         8.        03
         0.  00    04
         0.  00    05
        90.  00    06
      -150.  00    07
         5. -03    08
      62.5-03      09
 7.3107032  06     10
-4.3243799  06     11
         8.  00    12
        64.  00    13
       512.  00    14
 3.90625-03        15
976.5625-06        16
         2. -03    17
       181.  09    18
      10.3  09     19
       280. -03    20
      7.17  09     21
        10. -09    22
      12.5-06      23
         0.  00    24
       600. -03    25
        16.  00    26
181.81114  09      27
10.346159  09      28
2.8969244  09      29
      7.17  09     30
         0.  00    31
         1.  00    32
         0.  00    33
         0.  00    34
      -500. -03    35
         0.  00    36
         0.  00    37
         0.  00    38
         0.  00    39
         1.  00    40
       125. -06    41
49.487787  09      42
26.880431  09      43
 85.73249  09      44
19.710431  09      45
        -8.  00    46
         0.  00    47
         0.  00    48
       180.  00    49
       360.  00    50
 7.3107032  06     51
 7.3107032  06     52
         0.  00    53
 .16219  06        54
-2.16219  06        55
         0.  00    56
    -1.5-06         57
   1.125-03         58
216.59641  00       59
```

TAPE #9: MODULUS OF GENERAL LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results of Tape #8 are in storage.			
1	Calculate A^*_{ij}, B^*_{ij}, D^*_{ij}		A	D^*_{26}
2*	Calculate A_{ij}, B_{ij}, D_{ij}		B	D_{26}

* This is a necessary step before the matrix inversion in Tape #10. Inversion of the normalized modulus in Step 1 is not meaningful.

Tape# 9 Title MODULUS OF GENERAL LAMINATES

A'	B'	C'	D'	E'
A $A^*_{ij}, B^*_{ij}, D^*_{ij}$	B A_{ij}, B_{ij}, D_{ij}	C	D	E

00	θ_1	15	A_{16}	30	Q_{66}	45	U_3
01	n_1	16	A_{26}	31	V^*_{1A}	46	$-n/2$
02	θ_2	17	B_{11}	32	V^*_{2A}	47	V^*_{3D}
03	n_2	18	B_{22}	33	V^*_{3A}	48	V^*_{4D}
04	θ_3	19	B_{12}	34	V^*_{4A}	49	$2\theta_i$
05	n_3	20	B_{66}	35	V^*_{1B}	50	$4\theta_i$
06	θ_4	21	B_{16}	36	V^*_{2B}	51	$N_1^{N^*}$
07	ΔT	22	B_{26}	37	V^*_{3B}	52	$N_2^{N^*}$
08	c	23	D_{11}	38	V^*_{4B}	53	$N_6^{N^*}$
09	U_4	24	D_{22}	39	V^*_{1D}	54	$M_1^{N^*}$
10	U_1	25	D_{12}	40	V^*_{2D}	55	$M_2^{N^*}$
11	A_{11}	26	D_{66}	41	h_o	56	$M_6^{N^*}$
12	A_{22}	27	D_{16}	42	$\frac{1}{2}(U_1+U_4)$	57	e_x
13	A_{12}	28	D_{26}	43	$U_5=\frac{1}{2}(U_1-U_4)$	58	e_y
14	A_{66}	29	Q_{12}	44	U_2	59	h

A^*_{ij}

000	76	LBL
001	11	A
002	01	1
003	02	2
004	66	PAU
005	43	RCL
006	17	17
007	42	STO
008	59	59
009	43	RCL
010	42	42
011	75	-
012	43	RCL
013	43	43
014	95	=
015	42	STO
016	09	09
017	85	+
018	02	2
019	65	×
020	43	RCL
021	43	43
022	95	=
023	42	STO
024	10	10
025	85	+
026	43	RCL
027	44	44
028	65	×
029	43	RCL
030	31	31
031	85	+
032	43	RCL
033	32	32
034	65	×
035	43	RCL
036	45	45
037	95	=
038	42	STO
039	11	11
040	75	-
041	02	2
042	65	×
043	43	RCL
044	44	44
045	65	×
046	43	RCL
047	31	31
048	95	=
049	42	STO
050	12	12
051	43	RCL
052	09	09
053	75	-
054	43	RCL
055	45	45
056	65	×
057	43	RCL
058	32	32
059	95	=
060	42	STO
061	13	13
062	75	-
063	43	RCL
064	42	42
065	85	+
066	02	2
067	65	×
068	43	RCL
069	43	43
070	95	=
071	42	STO
072	14	14
073	43	RCL
074	33	33
075	65	×
076	43	RCL
077	44	44
078	55	÷
079	02	2
080	55	÷
081	43	RCL
082	34	34
083	65	×
084	43	RCL
085	45	45
086	95	=
087	42	STO
088	15	15
089	75	-
090	02	2
091	65	×
092	43	RCL
093	45	45
094	65	×
095	43	RCL
096	34	34
097	95	=
098	42	STO
099	16	16

B^*_{ij}

100	43	RCL
101	44	44
102	65	×
103	43	RCL
104	35	35
105	85	+
106	43	RCL
107	45	45
108	65	×
109	43	RCL
110	36	36
111	95	=
112	42	STO
113	17	17
114	75	-
115	02	2
116	65	×
117	43	RCL
118	44	44
119	65	×
120	43	RCL
121	35	35
122	95	=
123	42	STO
124	18	18
125	43	RCL
126	45	45
127	65	×
128	43	RCL
129	36	36
130	95	=
131	94	+/-
132	42	STO
133	19	19
134	42	STO
135	20	20
136	43	RCL
137	44	44
138	65	×
139	43	RCL
140	37	37
141	55	÷
142	02	2
143	85	+
144	43	RCL
145	45	45
146	65	×
147	43	RCL
148	38	38
149	95	=
150	42	STO
151	21	21
152	75	-
153	02	2
154	65	×
155	43	RCL
156	45	45
157	65	×
158	43	RCL
159	38	38
160	95	=
161	42	STO
162	22	22

D^*_{ij}

163	43	RCL
164	10	10
165	85	+
166	43	RCL
167	44	44
168	65	×
169	43	RCL
170	39	39
171	85	+
172	43	RCL
173	45	45
174	65	×
175	43	RCL
176	40	40
177	95	=
178	42	STO
179	23	23
180	75	-
181	02	2
182	65	×
183	43	RCL
184	44	44
185	65	×
186	43	RCL
187	39	39
188	95	=
189	42	STO
190	24	24
191	43	RCL
192	09	09
193	75	-
194	43	RCL
195	45	45
196	65	×
197	43	RCL
198	40	40
199	95	=
200	42	STO
201	25	25
202	75	-
203	43	RCL
204	42	42
205	85	+
206	02	2
207	65	×
208	43	RCL
209	43	43
210	95	=
211	42	STO
212	26	26
213	43	RCL
214	44	44
215	65	×
216	43	RCL
217	47	47
218	55	÷
219	02	2
220	85	+
221	43	RCL
222	45	45
223	65	×
224	43	RCL
225	48	48
226	95	=
227	42	STO
228	27	27
229	75	-
230	02	2
231	65	×
232	43	RCL
233	45	45
234	65	×
235	43	RCL
236	48	48
237	95	=
238	42	STO
239	28	28
240	91	R/S

A_{ij}

241	76	LBL
242	12	B
243	43	RCL
244	56	56
245	49	PRD
246	11	11
247	49	PRD
248	12	12
249	49	PRD
250	13	13
251	49	PRD
252	14	14
253	49	PRD
254	15	15
255	49	PRD
256	16	16

B_{ij}

257	43	RCL
258	55	÷
259	02	2
260	95	=
261	49	PRD
262	17	17
263	49	PRD
264	18	18
265	49	PRD
266	19	19
267	49	PRD
268	20	20
269	49	PRD
270	21	21
271	49	PRD
272	22	22

D_{ij}

274	43	RCL
275	59	59
276	55	÷
277	06	6
278	95	=
279	49	PRD
280	23	23
281	49	PRD
282	24	24
283	49	PRD
284	25	25
285	49	PRD
286	26	26
287	49	PRD
288	27	27
289	49	PRD
290	28	28
291	00	0
292	00	0
293	33	INV
294	90	LST
295	91	R/S
296	00	0
297	00	0
298	00	0
299	00	0
300	00	0
301	00	0
302	00	0
303	00	0
304	00	0
305	00	0
306	00	0
307	00	0
308	00	0
309	00	0
310	00	0
311	00	0
312	00	0
313	00	0
314	00	0
315	00	0
316	00	0
317	00	0
318	00	0
319	00	0

	45.	00	00
	0.		01
	-45.		02
	8.		03
	0.	00	04
	0.	00	05
	-45.	00	06
	-150.	00	07
	5.	-03	08
	22.607356	09	09
	76.368218	09	10
	113.31557	06	11
	113.31557	06	12
A_{ij}	84.635573	06	13
	93.181724	06	14
	0.	00	15
	0.	00	16
	0.	00	17
	0.	00	18
	0.	00	19
B_{ij}	0.	00	20
	-42.866245	03	21
	-42.866245	03	22
	37.771858	00	23
	37.771858	00	24
	28.211858	00	25
D_{ij}	31.060575	00	26
	0.	00	27
	0.	00	28
	2.8969244	09	29
	7.17	09	30
	0.	00	31
	-1.	00	32
	0.	00	33
	0.	00	34
	0.	00	35
	0.	00	36
	-500.	-03	37
	0.	00	38
	0.	00	39
	-1.	00	40
	125.	-06	41
	49.487787	09	42
	26.880431	09	43
	85.73249	09	44
	19.710431	09	45
	-8.	00	46
	0.	00	47
	0.	00	48
	-90.	00	49
	-180.	00	50
	7.3107032	06	51
	7.3107032	06	52
	0.	00	53
	0.	00	54
	0.	00	55
	2.16219	06	56
	-1.5	-06	57
	1.125	-03	58
	2.	-03	59

	0.		00
	0.		01
	90.		02
	8.		03
	0.	00	04
	0.	00	05
	90.	00	06
	-150.	00	07
	5.	-03	08
	22.607356	09	09
	76.368218	09	10
	192.1573	06	11
	192.1573	06	12
	5.7938489	06	13
	14.34	06	14
	0.	00	15
	0.	00	16
	-85.73249	03	17
	85.73249	03	18
	0.	00	19
	0.	00	20
	0.	00	21
	0.	00	22
	64.052433	00	23
	64.052433	00	24
	1.931283	00	25
	4.78	00	26
	0.	00	27
	0.	00	28
	2.8969244	09	29
	7.17	09	30
	0.	00	31
	1.	00	32
	0.	00	33
	0.	00	34
	-500.	-03	35
	0.	00	36
	0.	00	37
	0.	00	38
	0.	00	39
	1.	00	40
	125.	-06	41
	49.487787	09	42
	26.880431	09	43
	85.73249	09	44
	19.710431	09	45
	-8.	00	46
	0.	00	47
	0.	00	48
	180.	00	49
	360.	00	50
	7.3107032	06	51
	7.3107032	06	52
	0.	00	53
	2.16219	06	54
	-2.16219	06	55
	0.	00	56
	-1.5	-06	57
	1.125	-03	58
	2.	-03	59

TAPE #10: COMPLIANCE OF GENERAL LAMINATES
(Use Side #1 only)

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results from Tape #9 (Step 2) must be in storage.			
1	Calculate α_{ij}, β_{ij}, δ_{ij}*		A	1
2	Calculate N_i^N, M_i^N		B	51

* Time required for calculation is 230" or 3'50".

TAPE #10A: INVERSION CHECK

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Check Inversion**		A	7
2	Data Rearrangement		D	51

** Time required is 110" or 1'50".

Tape# 10 Title COMPLIANCE OF GENERAL LAMINATES

A'	B'	C'	D'	E'
A $\alpha_{ij}, \beta_{ij}, \delta_{ij}$	B N_i^N, M_i^N	C	D	E

00	15 α_{16}	30 δ_{16}	45
01	16 α_{26}	31 δ_{26}	46
02	17 β_{11}	32	47
03	18 β_{22}	33	48
04	19 β_{12}	34	49
05	20 β_{21}	35	50
06	21 β_{66}	36	51 N_1^N
07	22 β_{16}	37	52 N_2^N
08	23 β_{61}	38	53 N_6^N
09	24 β_{26}	39	54 M_1^N
10	25 β_{62}	40	55 M_2^N
11 α_{11}	26 δ_{11}	41	56 M_6^N
12 α_{22}	27 δ_{22}	42	57 e_x
13 α_{12}	28 δ_{12}	43	58 e_y
14 α_{66}	29 δ_{21}	44	59 h

Data Rearrang

000	76	LBL	
001	11	A	
002	02	2	
003	09	9	
004	00	0	
005	56	FAU	
006	43	RCL	
007	11	11	
008	42	STO	
009	08	08	
010	43	RCL	
011	13	13	
012	42	STO	
013	09	09	
014	43	RCL	
015	15	15	
016	42	STO	
017	10	10	
018	43	RCL	
019	23	23	
020	42	STO	
021	29	29	
022	43	RCL	
023	34	34	
024	42	STO	
025	36	36	
026	43	RCL	
027	25	25	
028	42	STO	
029	30	30	
030	42	STO	
031	35	35	
032	43	RCL	
033	26	26	
034	42	STO	
035	41	41	
036	42	STO	
037	[illegible]	[illegible]	
038	43	RCL	
039	[illegible]	[illegible]	
040	[illegible]	STO	
041	41	41	
042	42	STO	
043	[illegible]	[illegible]	
044	43	RCL	
045	[illegible]	[illegible]	
046	[illegible]	STO	
047	[illegible]	[illegible]	
048	43	RCL	
049	[illegible]	17	
050	[illegible]	STO	
051	[illegible]	11	
052	42	STO	
053	[illegible]	26	
054	43	RCL	
055	21	21	
056	42	STO	
057	13	13	
058	42	STO	
059	28	28	
060	42	STO	
061	38	38	
062	42	STO	
063	[illegible]	38	
064	43	RCL	
065	12	12	
066	42	STO	
067	15	15	
068	43	RCL	
069	19	19	
070	42	STO	
071	17	17	
072	42	STO	
073	[illegible]	27	
074	42	STO	
075	32	32	
076	42	STO	
077	12	12	
078	43	RCL	
079	20	20	
080	42	STO	
081	40	40	
082	42	STO	
083	25	25	
084	43	RCL	
085	18	18	
086	42	STO	
087	33	33	
088	43	RCL	
089	22	22	
090	42	STO	
091	19	19	
092	42	STO	
093	24	24	
094	42	STO	
095	34	34	
096	42	STO	
097	39	39	
098	43	RCL	
099	14	14	
100	42	STO	
101	22	22	
102	43	RCL	
103	10	10	
104	42	STO	
105	20	20	
106	43	RCL	
107	16	16	
108	42	STO	
109	21	21	
110	43	RCL	
111	09	09	
112	42	STO	
113	14	14	
114	00	0	
115	49	PRD	
116	00	00	
117	49	PRD	
118	01	01	
119	49	PRD	
120	02	02	
121	49	PRD	
122	03	03	
123	49	PRD	
124	04	04	
125	49	PRD	
126	05	05	
127	49	PRD	
128	06	06	
129	49	PRD	
130	07	07	
131	49	PRD	
132	44	44	
133	49	PRD	
134	45	45	
135	49	PRD	
136	46	46	
137	49	PRD	
138	47	47	
139	49	PRD	
140	48	48	
141	49	PRD	
142	49	49	
143	49	PRD	
144	50	50	
145	98	ADV	

Inversion

146	00	0	
147	36	PGM	
148	02	02	
149	11	A	
150	01	1	
151	36	PGM	
152	02	02	
153	12	B	
154	36	PGM	
155	02	02	
156	13	C	
157	25	CLR	
158	36	PGM	
159	02	02	
160	17	B'	
161	91	R/S	

N_A^N, M_A^N

162	76	LBL	
163	12	B	
164	43	RCL	
165	59	59	
166	49	PRD	
167	51	51	
168	49	PRD	
169	52	52	
170	49	PRD	
171	53	53	
172	43	RCL	
173	59	59	
174	33	X²	
175	55	-	
176	02	2	
177	95	=	
178	49	PRD	
179	54	54	
180	49	PRD	
181	55	55	
182	49	PRD	
183	56	56	
184	05	5	
185	01	1	
186	22	INV	
187	90	LST	
188	98	ADV	
189	91	R/S	
190	00	0	
191	00	0	
192	00	0	
193	00	0	
194	00	0	
195	00	0	
196	00	0	
197	00	0	
198	00	0	
199	00	0	
200	00	0	
201	00	0	
202	00	0	
203	00	0	
204	00	0	
205	00	0	
206	00	0	
207	00	0	
208	00	0	
209	00	0	
210	00	0	
211	00	0	
212	00	0	
213	00	0	
214	00	0	
215	00	0	
216	00	0	
217	00	0	
218	00	0	
219	00	0	
220	00	0	
221	00	0	
222	00	0	
223	00	0	
224	00	0	
225	00	0	
226	00	0	
227	00	0	
228	00	0	
229	00	0	
230	00	0	
231	00	0	
232	00	0	
233	00	0	
234	00	0	
235	00	0	
236	00	0	
237	00	0	
238	00	0	
239	00	0	

```
000  76 LBL
001  11  A
002  01  1
003  42 STO
004  00  00
005  01  1
006  01  1
007  00  0
008  66 PAU
009  43 RCL
010  00  00
011  32 X:T
012  12  B
013  69 DP
014  20  20
015  07  7
016  32 X:T
017  43 RCL
018  00  00
019  67  EQ
020  58 FIX
021  .   .
022  00  0
023  09  9
024  76 LBL
025  58 FIX
026  91 R/S
027  76 LBL
028  12  B
029  43 RCL
030  44  44
031  67  EQ
032  30  X²
033  43 RCL
034  45  45
035  67  EQ
036  34 FX
037  43 RCL
038  46  46
039  67  EQ
040  35 1/X
041  43 RCL
042  47  47
043  67  EQ
044  23 LNX
045  43 RCL
046  48  48
047  67  EQ
048  28 LOG
049  43 RCL
050  49  49
051  67  EQ
052  24 CE
053  12  B
054  76 LBL
055  33 X²
056  43 RCL
057  44  44
058  48 EXC
059  49  49
060  48 EXC
061  44  44
062  08  8
063  42 STO
064  01  01
065  03  3
066  08  8
067  42 STO
068  02  02
069  15  E
070  76 LBL
071  13  C
072  01  1
073  32 X:T
074  43 RCL
075  49  49
076  67  EQ
077  16 A'
078  60 DEG
079  76 LBL
080  60 DEG
081  02  2
082  32 X:T
083  43 RCL
084  49  49
085  67  EQ
086  17 B'
087  70 RAD
088  76 LBL
089  70 RAD
090  03  3
091  32 X:T
092  43 RCL
093  49  49
094  67  EQ
095  10 E'
096  80 GRD
097  76 LBL
098  80 GRD
099  04  4
100  32 X:T
101  43 RCL
102  49  49
103  67  EQ
104  19 D'
105  50 I×I
106  76 LBL
107  50 I×I
108  05  5
109  32 X:T
110  43 RCL
111  49  49
112  67  EQ
113  38 SIN
114  45 Y^X
115  76 LBL
116  45 Y^X
117  06  6
118  32 X:T
119  43 RCL
120  49  49
121  67  EQ
122  39 COS
123  13  C
124  76 LBL
125  16 A'
126  01  1
127  42 STO
128  06  06
129  43 RCL
130  49  49
131  48 EXC
132  44  44
133  48 EXC
134  49  49
135  03  3
136  08  8
137  42 STO
138  04  04
139  08  8
140  42 STO
141  05  05
142  18 C'
143  76 LBL
144  18 C'
145  07  7
146  32 X:T
147  43 RCL
148  06  06
149  67  EQ
150  00  00
151  13  13
152  73 RC*
153  04  04
154  63 EX*
155  05  05
156  63 EX*
157  04  04
158  69 DP
159  24  24
160  69 DP
161  25  25
162  69 DP
163  26  26
164  61 GTO
165  01  01
166  47  47
167  76 LBL
168  34 FX
169  01  1
170  04  4
171  42 STO
172  01  01
173  03  3
174  08  8
175  42 STO
176  02  02
177  43 RCL
178  45  45
179  48 EXC
180  49  49
181  48 EXC
182  45  45
183  15  E
184  76 LBL
185  35 1/X
186  43 RCL
187  46  46
188  48 EXC
189  49  49
190  48 EXC
191  46  46
192  02  2
193  00  0
194  42 STO
195  01  01
196  03  3
197  06  6
198  42 STO
199  02  02
200  15  E
201  76 LBL
202  23 LNX
203  43 RCL
204  47  47
205  48 EXC
206  49  49
207  48 EXC
208  47  47
209  02  2
210  06  6
211  42 STO
212  01  01
213  03  3
214  08  8
215  42 STO
216  02  02
217  15  E
218  76 LBL
219  28 LOG
220  43 RCL
221  48  48
222  48 EXC
223  49  49
224  48 EXC
225  48  48
226  03  3
227  02  2
228  42 STO
229  01  01
230  03  3
231  08  8
232  42 STO
233  02  02
234  15  E
235  76 LBL
236  24 CE
237  03  3
238  08  8
239  42 STO
```

```
240  01  01
241  03  3
242  08  8
243  42 STO
244  02  02
245  15  E
246  76 LBL
247  17  B'
248  01  1
249  42 STO
250  06  06
251  43 RCL
252  49  49
253  48 EXC
254  45  45
255  48 EXC
256  49  49
257  03  3
258  08  8
259  42 STO
260  04  04
261  01  1
262  04  4
263  42 STO
264  05  05
265  18  C'
266  76 LBL
267  10  E'
268  01  1
269  42 STO
270  06  06
271  43 RCL
272  49  49
273  48 EXC
274  46  46
275  48 EXC
276  49  49
277  02  2
278  06  6
279  42 STO
280  04  04
281  02  2
282  00  0
283  42 STO
284  05  05
285  18  C'
286  76 LBL
287  19  D'
288  01  1
289  42 STO
290  06  06
291  43 RCL
292  49  49
293  48 EXC
294  47  47
295  48 EXC
296  49  49
297  03  3
298  08  8
299  42 STO
300  04  04
301  02  2
302  06  6
303  42 STO
304  05  05
305  18  C'
306  76 LBL
307  38 SIN
308  01  1
309  42 STO
310  06  06
311  43 RCL
312  49  49
313  48 EXC
314  48  48
315  48 EXC
316  49  49
317  03  3
318  08  8
319  42 STO
320  04  04
321  03  3
322  02  2
323  42 STO
324  05  05
325  18  C'
326  76 LBL
327  39 COS
328  01  1
329  42 STO
330  06  06
331  02  2
332  06  6
333  42 STO
334  04  04
335  03  3
336  08  8
337  42 STO
338  05  05
339  18  C'
340  76 LBL
341  15  E
342  01  1
343  42 STO
344  07  07
345  07  7
346  32 XIT
347  43 RCL
348  07  07
349  57  EQ
350  11  0
351  73 RC+
352  01  01
353  63 EX+
354  02  02
355  63 EX+
356  01  01
357  69 OP
358  21  21
359  69 OP
360  22  22
361  69 OP
362  27  27
363  61 GTO
364  03  03
365  47  47
366  76 LBL
367  14  D
368  05  5
369  66 PAU
370  43 RCL
371  08  08
372  42 STO
373  11  11
374  99 PRT
375  43 RCL
376  15  15
377  42 STO
378  12  12
379  99 PRT
380  43 RCL
381  09  09
382  42 STO
383  13  13
384  99 PRT
385  43 RCL
386  22  22
387  42 STO
388  14  14
389  99 PRT
390  43 RCL
391  10  10
392  42 STO
393  15  15
394  99 PRT
395  43 RCL
396  16  16
397  99 PRT
398  98 ADV
399  43 RCL
400  17  17
401  42 STO
402  17  17
403  99 PRT
404  43 RCL
405  18  18
406  99 PRT
407  43 RCL
408  32  32
409  42 STO
410  19  19
411  99 PRT
412  43 RCL
413  27  27
414  42 STO
415  20  20
416  99 PRT
417  43 RCL
418  25  25
419  42 STO
420  21  21
421  99 PRT
422  43 RCL
423  38  38
424  42 STO
425  22  22
426  99 PRT
427  43 RCL
428  28  28
429  42 STO
430  23  23
431  99 PRT
432  43 RCL
433  39  39
434  42 STO
435  24  24
436  99 PRT
437  43 RCL
438  34  34
439  42 STO
440  25  25
441  99 PRT
442  98 ADV
443  43 RCL
444  29  29
445  42 STO
446  26  26
447  99 PRT
448  43 RCL
449  36  36
450  42 STO
451  27  27
452  99 PRT
453  43 RCL
454  30  30
455  42 STO
456  28  28
457  99 PRT
458  43 RCL
459  43  43
460  42 STO
461  29  29
462  99 PRT
463  43 RCL
464  31  31
465  42 STO
466  30  30
467  99 PRT
468  43 RCL
469  37  37
470  42 STO
471  31  31
472  99 PRT
473  98 ADV
474  05  5
475  01  1
476  22 INV
477  90 LST
478  98 ADV
479  91 R/S
```

Data Rearrang.

	6. 00	14.621406 03	51	N_i^N		6. 00	14.621406 03	51
		14.621406 03	52				14.621406 03	52
		0. 00	53				0. 00	53
		0. 00	54				4.3243799 00	54
	1.677421 27	0. 00	55	M_i^N		1.677421 27	-4.3243799 00	55
		4.3243799 00	56				0. 00	56
		-1.5-06	57				-1.5-06	57
		1.125-03	58				1.125-03	58
	23.712556-09 α_{11}	2.-03	59			12.948013-09	2.-03	59
	23.712556-09 α_{22}					12.948013-09		
	-11.154947-09 α_{12}					-390.40323-12		
	26.676832-09 α_{44}					69.735007-09		
	0. 00 α_{16}	0. 00	00			0. 00	0. 00	00
	0. 00 α_{26}	43. 00	01			0. 00	43. 00	01
		43. 00	02				43. 00	02
	0. 00 β_{11}	49. 00	03			17.330573-06	49. 00	03
	0. 00 β_{22}	6. 00	04			-17.330573-06	6. 00	04
	0. 00 β_{12}	7. 00	05			-82.744711-18	7. 00	05
	0. 00 β_{21}	1.677421 27	06			84.9-18	1.677421 27	06
	0. 00 β_{66}	6. 00	07			0. 00	6. 00	07
	17.330573-06 β_{16}	23.712556-09	08			0. 00	12.948013-09	08
	17.330573-06 β_{61}	-11.154947-09	09			0. 00	-390.40323-12	09
	17.330573-06 β_{26}	0. 00	10			0. 00	0. 00	10
	17.330573-06 β_{62}	23.712556-09	11			0. 00	12.948013-09	11
		23.712556-09	12				12.948013-09	12
		-11.154947-09	13				-390.40323-12	13
	71.137669-03 δ_{11}	26.676832-09	14			38.844038-03	69.735007-09	14
	71.137669-03 δ_{22}	0. 00	15			38.844038-03	0. 00	15
	-33.464841-03 δ_{12}	0. 00	16			-1.1712097-03	0. 00	16
	80.030496-03 δ_{66}	0. 00	17			209.20502-03	17.330573-06	17
	0. 00 δ_{16}	0. 00	18			0. 00	-17.330573-06	18
	0. 00 δ_{26}	0. 00	19			0. 00	-82.744711-18	19
		0. 00	20				84.9-18	20
		0. 00	21				0. 00	21
		17.330573-06	22				0. 00	22
		17.330573-06	23				0. 00	23
		17.330573-06	24				0. 00	24
		17.330573-06	25				0. 00	25
		71.137669-03	26				38.844038-03	26
		71.137669-03	27				38.844038-03	27
		-33.464841-03	28				-1.1712097-03	28
		80.030496-03	29				209.20502-03	29
		0. 00	30				0. 00	30
		0. 00	31				0. 00	31
		0. 00	32				-82.744711-18	32
		0. 00	33				-17.330573-06	33
		17.330573-06	34				0. 00	34
		-33.464841-03	35				-1.1712097-03	35
		71.137669-03	36				38.844038-03	36
		0. 00	37				0. 00	37
		17.330573-06	38				0. 00	38
		17.330573-06	39				0. 00	39
		0. 00	40				0. 00	40
		0. 00	41				0. 00	41
		0. 00	42				0. 00	42
		80.030496-03	43				209.20502-03	43
		1. 00	44				1. 00	44
		2. 00	45				2. 00	45
		3. 00	46				3. 00	46
		4. 00	47				4. 00	47
		5. 00	48				5. 00	48
		6. 00	49				6. 00	49
		0. 00	50				0. 00	50
		14.621406 03	51				14.621406 03	51
		14.621406 03	52				14.621406 03	52
		0. 00	53				0. 00	53
		0. 00	54				4.3243799 00	54
		0. 00	55				-4.3243799 00	55
		4.3243799 00	56				0. 00	56
		-1.5-06	57				-1.5-06	57
		1.125-03	58				1.125-03	58
		2.-03	59				2.-03	59

TAPE #11: IN-PLANE STRAINS AND CURVATURE OF GENERAL LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results of Tape #10A are in storage.			
1	Calculate ϵ_i^{oN}, k_i^N		A	k_6^N
2	Calculate ϵ_i^N	z	D	ϵ_6^N
3	Calculate $\epsilon_i^{o(N+M)}$, k_i^{N+M}	N_1^M	B	N_1^M
		N_2^M	R/S	N_2^M
		N_6^M	R/S	N_6^M
		M_1^M	R/S	M_1^M
		M_2^M	R/S	M_2^M
		M_6^M	R/S	k_6^M
4	Calculate ϵ_i^M	z	D	ϵ_6^M

Tape# 11 Title IN-PLANE STRAIN AND CURVATURE OF GENERAL LAMINATES

A'	B'	C'	D'	E'
A e_i^{oN}, k_i^N	B e_i^{oM}, k_i^{oM}	C	D e_i^N, e_i^M	E

00	15 α_{16}	30 δ_{16}	45 Σe_1
01 e_1^{oN}	16 α_{26}	31 δ_{26}	46 Σe_2
02 e_2^{oN}	17 β_{11}	32	47 Σe_6
03 e_6^{oN}	18 β_{22}	33	48 Σk_1
04 k_1^N	19 β_{12}	34	49 Σk_2
05 k_2^N	20 β_{21}	35	50 Σk_6
06 k_6^N	21 β_{66}	36 e_1^{oM}	51 N_1^N, N_1^M
07 e_1	22 β_{16}	37 e_2^{oM}	52 N_2^N, N_2^M
08 e_2	23 β_{61}	38 e_6^{oM}	53 N_6^N, N_6^M
09 e_6	24 β_{26}	39 k_1^M	54 M_1^N, M_1^M
10	25 β_{62}	40 k_2^M	55 M_2^N, M_2^M
11 α_{11}	26 δ_{11}	41 k_6^M	56 M_6^N, M_6^M
12 α_{22}	27 δ_{22}	42	57 e_x
13 α_{12}	28 δ_{12}	43	58 e_y
14 α_{66}	29 δ_{66}	44	59 h, z

TAPE # 11 IN-PLANE STRAINS AND CURVATURE GENERAL LAMINATES

ϵ_x^{0N}

```
000  76 LBL
001  11  A
002  71 SBR
003  36 X≥
004  43 RCL
005  45  45
006  42 STO
007  01  01
008  43 RCL
009  46  46
010  42 STO
011  02  02
012  43 RCL
013  47  47
014  42 STO
015  03  03
016  43 RCL
017  48  48
018  42 STO
019  04  04
020  43 RCL
021  49  49
022  42 STO
023  05  05
024  43 RCL
025  50  50
026  42 STO
027  06  06
028  91 R/S
```

ϵ_x^{0M}

```
029  76 LBL
030  12  B
031  42 STO
032  51  51
033  99 PRT
034  91 R/S
035  42 STO
036  52  52
037  99 PRT
038  91 R/S
039  42 STO
040  53  53
041  99 PRT
042  91 R/S
043  42 STO
044  54  54
045  99 PRT
046  91 R/S
047  42 STO
048  55  55
049  99 PRT
050  91 R/S
051  42 STO
052  56  56
053  99 PRT
054  71 SBR
055  36 X≥
056  43 RCL
057  45  45
058  42 STO
059  36  36
060  43 RCL
061  46  46
062  42 STO
063  37  37
064  43 RCL
065  47  47
066  42 STO
067  38  38
068  43 RCL
069  48  48
070  42 STO
071  39  39
072  42 RCL
073  49  49
074  42 STO
075  40  40
076  43 RCL
077  50  50
078  42 STO
079  41  41
080  91 R/S
081  76 LBL
082  30 X≠
083  01  1
084  01  1
085  66 PAU
086  43 RCL
087  11  11
088  65  ×
089  43 RCL
090  51  51
091  85  +
092  43 RCL
093  12  13
094  65  ×
095  43 RCL
096  52  52
097  85  +
098  43 RCL
099  15  15
100  65  ×
101  43 RCL
102  53  53
103  85  +
104  43 RCL
105  17  17
106  65  ×
107  43 RCL
108  54  54
109  85  +
110  43 RCL
111  19  19
112  65  ×
113  43 RCL
114  55  55
115  85  +
116  43 RCL
117  22  22
118  65  ×
119  43 RCL
120  56  56
121  95  =
122  42 STO
123  45  45
124  43 RCL
125  13  13
126  65  ×
127  43 RCL
128  51  51
129  85  +
130  43 RCL
131  12  12
132  65  ×
133  43 RCL
134  52  52
135  85  +
136  43 RCL
137  16  16
138  65  ×
139  43 RCL
140  53  53
141  85  +
142  43 RCL
143  20  20
144  65  ×
145  43 RCL
146  54  54
147  85  +
148  43 RCL
149  18  18
150  65  ×
151  43 RCL
152  55  55
153  85  +
154  43 RCL
155  24  24
156  65  ×
157  43 RCL
158  56  56
159  95  =
160  42 STO
161  46  46
162  43 RCL
163  15  15
164  65  ×
165  43 RCL
166  51  51
167  85  +
168  43 RCL
169  16  16
170  65  ×
171  43 RCL
172  52  52
173  85  +
174  43 RCL
175  14  14
176  65  ×
177  43 RCL
178  53  53
179  85  +
180  43 RCL
181  23  23
182  65  ×
183  43 RCL
184  54  54
185  85  +
186  43 RCL
187  25  25
188  65  ×
189  43 RCL
190  55  55
191  85  +
192  43 RCL
193  21  21
194  65  ×
195  43 RCL
196  56  56
197  95  =
198  42 STO
199  47  47
200  43 RCL
201  17  17
202  65  ×
203  43 RCL
204  51  51
205  85  +
206  43 RCL
207  20  20
208  65  ×
209  43 RCL
210  52  52
211  85  +
212  43 RCL
213  23  23
214  65  ×
215  43 RCL
216  53  53
217  85  +
218  43 RCL
219  26  26
220  65  ×
221  43 RCL
222  54  54
223  85  +
224  43 RCL
225  28  28
226  65  ×
227  43 RCL
228  55  55
229  85  +
230  43 RCL
231  30  30
232  65  ×
233  43 RCL
234  56  56
235  95  =
236  42 STO
237  48  48
238  43 RCL
239  19  19
```

```
240  65  ×
241  43 RCL
242  51  51
243  85  +
244  43 RCL
245  18  18
246  65  ×
247  43 RCL
248  52  52
249  85  +
250  43 RCL
251  25  25
252  65  ×
253  43 RCL
254  53  53
255  85  +
256  43 RCL
257  28  28
258  65  ×
259  43 RCL
260  54  54
261  85  +
262  43 RCL
263  27  27
264  65  ×
265  43 RCL
266  55  55
267  85  +
268  43 RCL
269  31  31
270  65  ×
271  43 RCL
272  56  56
273  95  =
274  42 STO
275  49  49
276  43 RCL
277  22  22
278  65  ×
279  43 RCL
280  51  51
281  85  +
282  43 RCL
283  24  24
284  65  ×
285  43 RCL
286  52  52
287  85  +
288  43 RCL
289  21  21
290  65  ×
291  43 RCL
292  53  53
293  85  +
294  43 RCL
295  30  30
296  65  ×
297  43 RCL
298  54  54
299  85  +
300  43 RCL
301  31  31
302  65  ×
303  43 RCL
304  55  55
305  85  +
306  43 RCL
307  29  29
308  65  ×
309  43 RCL
310  56  56
311  95  =
312  42 STO
313  50  50
314  92 RTN
315  91 R/S
316  76 LBL
317  14  D
318  42 STO
319  59  59
320  65  ×
321  43 RCL
322  48  48
323  85  +
324  43 RCL
325  45  45
326  95  =
327  99 PRT
328  42 STO
329  07  07
330  43 RCL
331  46  46
332  85  +
333  43 RCL
334  59  59
335  65  ×
336  43 RCL
337  49  49
338  95  =
339  99 PRT
340  42 STO
341  08  08
342  43 RCL
343  47  47
344  85  +
345  43 RCL
346  59  59
347  65  ×
348  43 RCL
349  50  50
350  95  =
351  42 STO
352  09  09
353  99 PRT
354  98 ADV
355  91 R/S
356  00  0
357  00  0
358  00  0
359  00  0
360  00  0
361  00  0
362  00  0
363  00  0
364  00  0
365  00  0
366  00  0
367  00  0
368  00  0
369  00  0
370  00  0
371  00  0
372  00  0
373  00  0
374  00  0
375  00  0
376  00  0
377  00  0
378  00  0
379  00  0
380  00  0
381  00  0
382  00  0
383  00  0
384  00  0
385  00  0
386  00  0
387  00  0
388  00  0
389  00  0
390  00  0
391  00  0
392  00  0
393  00  0
394  00  0
395  00  0
396  00  0
397  00  0
398  00  0
399  00  0
```

TAPE #11 IN-PLANE STRAINS AND CURVATURE/SAMPLE PROBLEMS

```
 258.5539-06
 258.5539-06
852.87698-06
```
ϵ_i^N

```
684.99239-06
-167.88459-06
0. 00
```

```
1. 00
0. 00
0. 00
```
N_i^M

```
1. 00
0. 00
0. 00
0. 00
0. 00
0. 00
```
M_i^M

```
23.712556-09
-11.154947-09
17.330573-09
```
ϵ_i^M

```
30.278586-09
-390.40323-12
0. 00
```

```
0. 00    00
258.5539-06    01
258.5539-06    02
0. 00    03
0. 00    04
0. 00    05
852.87698-03    06
23.712556-09    07
-11.154947-09    08
17.330573-09    09
0. 00    10
23.712556-09    11
23.712556-09    12
-11.154947-09    13
26.676832-09    14
0. 00    15
0. 00    16
0. 00    17
0. 00    18
0. 00    19
0. 00    20
0. 00    21
17.330573-06    22
17.330573-06    23
17.330573-06    24
17.330573-06    25
71.137669-03    26
71.137669-03    27
-33.464841-03    28
80.030496-03    29
0. 00    30
0. 00    31
0. 00    32
0. 00    33
17.330573-06    34
-33.464841-03    35
23.712556-09    36
-11.154947-09    37
0. 00    38
0. 00    39
0. 00    40
17.330573-06    41
0. 00    42
80.030496-03    43
1. 00    44
23.712556-09    45
-11.154947-09    46
0. 00    47
0. 00    48
0. 00    49
17.330573-06    50
1. 00    51
0. 00    52
0. 00    53
0. 00    54
0. 00    55
0. 00    56
-1.5-06    57
1.125-03    58
1.-03    59
```

```
0. 00    00
258.5539-06    01
258.5539-06    02
0. 00    03
426.43849-03    04
-426.43849-03    05
0. 00    06
30.278586-09    07
-390.40323-12    08
0. 00    09
0. 00    10
12.948013-09    11
12.948013-09    12
-390.40323-12    13
69.735007-09    14
0. 00    15
0. 00    16
17.330573-06    17
-17.330573-06    18
-82.744711-18    19
84.9-18    20
0. 00    21
0. 00    22
0. 00    23
0. 00    24
0. 00    25
38.844038-03    26
38.844038-03    27
-1.1712097-03    28
209.20502-03    29
0. 00    30
0. 00    31
-82.744711-18    32
-17.330573-06    33
0. 00    34
-1.1712097-03    35
12.948013-09    36
-390.40323-12    37
0. 00    38
17.330573-06    39
-82.744711-18    40
0. 00    41
0. 00    42
209.20502-03    43
1. 00    44
12.948013-09    45
-390.40323-12    46
0. 00    47
17.330573-06    48
-82.744711-18    49
0. 00    50
1. 00    51
0. 00    52
0. 00    53
0. 00    54
0. 00    55
0. 00    56
-1.5-06    57
1.125-03    58
1.-03    59
```

TAPE #12: STRENGTH RATIOS OF GENERAL LAMINATES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
0	Results of Tape #11 must be in storage			
1	Data rearrangement		A	e_y
2	Calculate strains ϵ_j^N , ϵ_j^M enter distance from middle plane	z	B	ϵ_6^M
3	Enter strength parameter in strain space. Use only Side #3 of ply data card; Side #4 must not be entered.		3	3
4	Calculate strength ratio	$\theta_i(z)$	E	R

Tape# 12 Title STRENGTH RATIOS OF GENERAL LAMINATES

A'	B'	C'	D'	E'
A	B e_j^N , e_j^M	C	D	E R

00 θ_i	15 e_6^{oM}	30	45
01 e_1^{oN}	16 k_1^M	31	46
02 e_2^{oN}	17 k_2^M	32 $e_1^M(\theta_i)$	47
03 e_6^{oN}	18 k_6^M	33 $e_2^M(\theta_i)$	48
04 k_1^N	19 e_x	34 $e_6^M(\theta_i)$	49
05 k_2^N	20 e_y	35	50
06 k_6^N	21 z	36	51
07 e_1^M	22 R	37	52
08 e_2^M	23 R'	38	53
09 e_6^M	24 $2\theta_i$	39	54 G_{xx}
10 e_1^N	25 $e_1^N(\theta_i)-e_x$	40	55 G_{yy}
11 e_2^N	26 $e_2^N(\theta_i)-e_y$	41	56 G_{xy}
12 e_6^N	27 $e_6^N(\theta_i)$	42	57 G_{ss}
13 e_1^{oM}	28	43	58 G_x
14 e_2^{oM}	29	44	59 G_y

Tape # 12 Strength Ratios General Laminates

```
000  76 LBL
001  11  A
002  43 RCL
003  36  36
004  42 STO
005  13  13
006  43 RCL
007  37  37
008  42 STO
009  14  14
010  43 RCL
011  38  38
012  42 STO
013  15  15
014  43 RCL
015  39  39
016  42 STO
017  16  16
018  43 RCL
019  40  40
020  42 STO
021  17  17
022  43 RCL
023  41  41
024  42 STO
025  18  18
026  43 RCL
027  59  59
028  42 STO
029  21  21
030  43 RCL
031  57  57
032  42 STO
033  19  19
034  43 RCL
035  58  58
036  42 STO
037  20  20
038  91 R/S
039  76 LBL
040  12  B
041  99 PRT
042  42 STO
043  21  21
044  65  ×
045  43 RCL
046  04  04
047  85  +
048  43 RCL
049  01  01
050  95  =
051  42 STO
052  10  10
053  43 RCL
054  21  21
055  65  ×
056  43 RCL
057  05  05
058  85  +
059  43 RCL
060  02  02
061  95  =
062  42 STO
063  11  11
064  43 RCL
065  21  21
066  65  ×
067  43 RCL
068  06  06
069  85  +
070  43 RCL
071  03  03
072  95  =
073  42 STO
074  12  12
075  43 RCL
076  21  21
077  65  ×
078  43 RCL
079  16  16
080  85  +
081  43 RCL
082  13  13
083  95  =
084  42 STO
085  07  07
086  43 RCL
087  21  21
088  65  ×
089  43 RCL
090  17  17
091  85  +
092  43 RCL
093  14  14
094  95  =
095  42 STO
096  08  08
097  43 RCL
098  21  21
099  65  ×
100  43 RCL
101  18  18
102  85  +
103  43 RCL
104  15  15
105  95  =
106  42 STO
107  09  09
108  43 RCL
109  10  10
110  99 PRT
111  43 RCL
112  11  11
113  99 PRT
114  43 RCL
115  12  12
116  99 PRT
117  98 ADV
118  43 RCL
119  07  07
120  99 PRT
121  43 RCL
122  08  08
123  99 PRT
124  43 RCL
125  09  09
126  99 PRT
127  98 ADV
128  91 R/S
129  76 LBL
130  15  E
131  42 STO
132  00  00
133  99 PRT
134  01  1
135  08  8
136  66 PAU
137  43 RCL
138  00  00
139  65  ×
140  02  2
141  95  =
142  42 STO
143  24  24
144  43 RCL
145  10  10
146  85  +
147  43 RCL
148  11  11
149  95  =
150  55  ÷
151  02  2
152  95  =
153  42 STO
154  28  28
155  75  -
156  43 RCL
157  11  11
158  95  =
159  42 STO
160  29  29
161  65  ×
162  43 RCL
163  24  24
164  39 COS
165  85  +
166  43 RCL
167  28  28
168  85  +
169  43 RCL
170  12  12
171  65  ×
172  43 RCL
173  24  24
174  38 SIN
175  55  ÷
176  02  2
177  75  -
178  43 RCL
179  19  19
180  95  =
181  42 STO
182  25  25
183  75  -
184  43 RCL
185  10  10
186  75  -
187  43 RCL
188  11  11
189  85  +
190  43 RCL
191  19  19
192  85  +
193  43 RCL
194  20  20
195  95  =
196  94 +/-
197  42 STO
198  26  26
199  43 RCL
200  12  12
201  65  ×
202  43 RCL
203  24  24
204  39 COS
205  75  -
206  43 RCL
207  29  29
208  65  ×
209  02  2
210  65  ×
211  43 RCL
212  24  24
213  38 SIN
214  95  =
215  42 STO
216  27  27
217  43 RCL
218  07  07
219  85  +
220  43 RCL
221  08  08
222  95  =
223  55  ÷
224  02  2
225  95  =
226  42 STO
227  28  28
228  75  -
229  43 RCL
230  08  08
231  95  =
232  42 STO
233  29  29
234  65  ×
235  43 RCL
236  24  24
237  39 COS
238  85  +
239  43 RCL
```

ϵ_i^N

ϵ_i^M

$\epsilon_j^N(\theta_i) - \epsilon_j$

ϵ_j^M

240	28	28	320	59	59	400	43	RCL
241	85	+	321	65	×	401	55	55
242	43	RCL	322	43	RCL	402	65	×
243	09	09	323	33	33	403	43	RCL
244	65	×	324	85	+	404	26	26
245	43	RCL	325	02	2	405	33	X²
246	24	24	326	65	×	406	75	-
247	38	SIN	327	53	(	407	43	RCL
248	55	÷	328	43	RCL	408	57	57
249	02	2	329	54	54	409	65	×
250	95	=	330	65	×	410	43	RCL
251	42	STO	331	43	RCL	411	27	27
252	32	32	332	32	32	412	33	X²
253	75	-	333	65	×	413	75	-
254	43	RCL	334	43	RCL	414	43	RCL
255	07	07	335	25	25	415	58	58
256	75	-	336	85	+	416	65	×
257	43	RCL	337	43	RCL	417	43	RCL
258	08	08	338	56	56	418	25	25
259	95	=	339	65	×	419	75	-
260	94	+/-	340	53	(	420	43	RCL
261	42	STO	341	43	RCL	421	59	59
262	33	33	342	32	32	422	65	×
263	43	RCL	343	65	×	423	43	RCL
264	09	09	344	43	RCL	424	26	26
265	65	×	345	26	26	425	95	=
266	43	RCL	346	85	+	426	55	÷
267	24	24	347	43	RCL	427	43	RCL
268	39	COS	348	33	33	428	28	28
269	75	-	349	65	×	429	85	+
270	43	RCL	350	43	RCL	430	43	RCL
271	29	29	351	25	25	431	29	29
272	65	×	352	54	)	432	33	X²
273	02	2	353	85	+	433	95	=
274	65	×	354	43	RCL	434	34	ΓX
275	43	RCL	355	55	55	435	42	STO
276	24	24	356	65	×	436	28	28
277	38	SIN	357	43	RCL	437	75	-
278	95	=	358	33	33	438	43	RCL
279	42	STO	359	65	×	439	29	29
280	34	34	360	43	RCL	440	95	=
281	33	X²	361	26	26	441	42	STO
282	65	×	362	85	+	442	22	22
283	43	RCL	363	43	RCL	443	99	PRT
284	57	57	364	57	57	444	75	-
285	85	+	365	65	×	445	02	2
286	43	RCL	366	43	RCL	446	65	×
287	54	54	367	34	34	447	43	RCL
288	65	×	368	65	×	448	28	28
289	43	RCL	369	43	RCL	449	95	=
290	32	32	370	27	27	450	94	+/-
291	33	X²	371	95	=	451	42	STO
292	85	+	372	55	÷	452	23	23
293	02	2	373	43	RCL	453	99	PRT
294	65	×	374	28	28	454	43	RCL
295	43	RCL	375	55	÷	455	22	22
296	56	56	376	02	2	456	91	R/S
297	65	×	377	95	=	457	00	0
298	43	RCL	378	42	STO	458	00	0
299	32	32	379	29	29	459	00	0
300	65	×	380	01	1	460	00	0
301	43	RCL	381	75	-	461	00	0
302	33	33	382	43	RCL	462	00	0
303	85	+	383	54	54	463	00	0
304	43	RCL	384	65	×	464	00	0
305	55	55	385	43	RCL	465	00	0
306	65	×	386	25	25	466	00	0
307	43	RCL	387	33	X²	467	00	0
308	33	33	388	75	-	468	00	0
309	33	X²	389	02	2	469	00	0
310	95	=	390	65	×	470	00	0
311	42	STO	391	43	RCL	471	00	0
312	28	28	392	56	56	472	00	0
313	43	RCL	393	65	×	473	00	0
314	58	58	394	43	RCL	474	00	0
315	65	×	395	25	25	475	00	0
316	43	RCL	396	65	×	476	00	0
317	32	32	397	43	RCL	477	00	0
318	85	+	398	26	26	478	00	0
319	43	RCL	399	75	-	479	00	0

R_i

TAPE #12 STRENGTH RATIOS/SAMPLE PROBLEMS

1.-03	ε	1.-03
258.5539-06	ε_A^N	684.99239-06
258.5539-06		-167.88459-06
852.87698-06		0. 00
23.712556-09	ε_A^M	30.278586-09
-11.154947-09		-390.40323-12
17.330573-09		0. 00
-45. 00	θ:(m)	90. 00
184.99191 03	R	143.37864 03
368.44954 03	R'	780.02708 03

-45. 00	00	90. 00	00
258.5539-06	01	258.5539-06	01
258.5539-06	02	258.5539-06	02
0. 00	03	0. 00	03
0. 00	04	426.43849-03	04
0. 00	05	-426.43849-03	05
852.87698-03	06	0. 00	06
23.712556-09	07	30.278586-09	07
-11.154947-09	08	-390.40323-12	08
17.330573-09	09	0. 00	09
258.5539-06	10	684.99239-06	10
258.5539-06	11	-167.88459-06	11
852.87698-06	12	0. 00	12
23.712556-09	13	12.948013-09	13
-11.154947-09	14	-390.40323-12	14
0. 00	15	0. 00	15
0. 00	16	17.330573-06	16
0. 00	17	-82.744711-18	17
17.330573-06	18	0. 00	18
-1.5-06	19	-1.5-06	19
1.125-03	20	1.125-03	20
1.-03	21	1.-03	21
184.99191 03	22	143.37864 03	22
368.44954 03	23	780.02708 03	23
-90. 00	24	180. 00	24
-166.38459-06	25	-166.38459-06	25
-440.00761-06	26	-440.00761-06	26
1.2-15	27	0. 00	27
276.72072 03	28	461.70321 03	28
184.99191 03	29	143.37864 03	29
7.17 09	30	7.17 09	30
0. 00	31	0. 00	31
-2.3864819-09	32	-390.40323-12	32
14.944091-09	33	30.278586-09	33
34.867503-09	34	0. 00	34
0. 00	35	0. 00	35
0. 00	36	0. 00	36
0. 00	37	0. 00	37
0. 00	38	0. 00	38
1.0044814 00	39	1.0044814 00	39
0. 00	40	0. 00	40
125.-06	41	125.-06	41
49.487787 09	42	49.487787 09	42
26.880431 09	43	26.880431 09	43
85.73249 09	44	85.73249 09	44
19.710431 09	45	19.710431 09	45
444.44444-21	46	444.44444-21	46
0. 00	47	0. 00	47
101.62602-18	48	101.62602-18	48
20.934959-09	49	20.934959-09	49
-500.-03	50	-500.-03	50
-3.3603243-18	51	-3.3603243-18	51
0. 00	52	0. 00	52
0. 00	53	0. 00	53
12.004384 03	54	12.004384 03	54
10.680652 03	55	10.680652 03	55
-3.0691032 03	56	-3.0691032 03	56
11.117842 03	57	11.117842 03	57
60.646995 00	58	60.646995 00	58
216.59641 00	59	216.59641 00	59

*U.S.Government Printing Office: 1981 — 757-002/325